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# Persistence and Structure

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**Abstract**
Perdurance is a mode of persistence. The heart of perdurance is a space-time analogy: a perduring object is extended in time in a way that is analogous to how a composite object is extended in space. This paper is a discussion of perdurance in light of the distinction between mereologically structured and unstructured objects. I show that while the standard formulation of perdurance captures the space-time analogy for unstructured objects, it fails to capture the space-time analogy for temporally and spatially structured objects. I conclude that there are substantially different ways for an object to be space-like temporally extended.

## 1 Perdurance and temporal parts

Material objects, such as a human organism, persist through time. That is, they exist at different moments of time. How does a persisting material object, or a continuant, persist through time? One mode of persistence is known as *perdurance*.[1] Perdurance is easy to grasp intuitively. The heart of perdurance, as it is widely understood, is an analogy between how composite material objects are in space and how material objects are in time: a perduring object is extended in time in a way that is analogous to how a composite object is extended in space. I shall call this the *perdurance intuition*.[2] As I shall use the term 'perdurance', it stands for a mode of persistence that is initially characterized by the perdurance intuition. This mode of persistence is the

[1] Classic discussions of perdurance and alternative modes of persistence, such as endurance, include Lewis (1986: 202 ff.) and Sider (1997, 2001).

[2] See, inter alia, Lewis (1986: 202) and Sider (1997: 197).

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topic of the present paper. How can this mode of persistence be characterized more precisely? That is, how can the perdurance intuition be sharpened?

The perdurance intuition is that a perduring object is extended in time in a way that is analogous to how a composite object is extended in space. How, to begin with, is a composite object extended in space? Here is a widely accepted picture. An entity $x$ is *exactly located* at a spatial region $y$ if and only if $x$ has the same shape and size as $y$, and $x$ stands in all the same spatial and spatiotemporal relations to other entities as does $y$.[3] Given this notion of exact location, we may say that an object is spatially extended just in case it is exactly located at a spatially extended region. Consider, as an example of a familiar composite object, a human organism. It is spatially extended, and hence it is exactly located at a spatially extended region. This region is not a mere spatial point. It is a region with different subregions—points and composites of points—as proper parts. Suppose that an organism, $o$, is exactly located at a certain extended region, $r$. It is common to hold that this is not a fundamental fact about $o$. Rather, $o$'s being exactly located at $r$ derives from facts about which proper parts $o$ has and at which regions these proper parts are exactly located: composite $o$ is exactly located at an extended region, $r$, because (i) $o$ is composed of non-identical parts $p_1 \ldots p_n$, (ii) $p_1 \ldots p_n$ are exactly located at non-identical regions $r_1 \ldots r_n$, respectively, and (iii) $r_1 \ldots r_n$ add up to $r$. In short, the organism is stretched out through space, in virtue of having different spatial parts at different spatial regions.

This is the template for perdurance. Just as a composite material object is stretched out through space by having different spatial parts at different spatial regions, a perduring material object is stretched out through time by having different temporal parts at different moments. Let me spell out this account of perdurance.

First, a continuant, such as a human organism, is *temporally extended*. Just as an organism is spatially extended by being exactly located at an extended spatial region, so an organism is temporally extended by being exactly located at an extended temporal region—in other words, by being exactly located at an interval of time. Here the notion of exact location is applied to temporal regions as well as spatial ones.[4] Notice that the organism is exactly located at a certain extended interval without being exactly located at any moment in the interval, just as the organism is exactly located at a certain extended spatial region without also being exactly located at any subregions of the latter.

Second, analogously to the case of a composite's spatial extension, a perduring continuant's temporal extension is not a fundamental fact about the continuant. Rather, organism $o$'s being exactly located at an extended interval, $T$, derives from facts about which *instantaneous temporal parts* $o$ has, and at which moments these temporal parts are exactly located: $o$ is exactly located at an interval, $T$, because (i) $o$ is composed of non-identical instantaneous temporal parts $tp_1 \ldots tp_n$, (ii) $tp_1 \ldots tp_n$ are exactly located at non-identical moments $t_1 \ldots t_n$, respectively, and (iii) $t_1 \ldots t_n$ add up to $T$. In short, the organism is stretched out through time, in virtue of having different instantaneous temporal parts at different moments.

[3] For this formulation and references, see Gilmore (2013: Sect. 2.1).

[4] The notion of exact temporal location is now widely used. See, inter alia, Gilmore (2006), Sattig (2006), and Parsons (2007) for further details and discussion.

What is an instantaneous temporal part of an object? Here is the standard definition, stated in terms of exact temporal location:

> (TP) For any $x$, $y$, and $t$, $x$ is an *instantaneous temporal part* of $y$ at $t$ $=_{df}$ (1) $x$ is exactly located at, and only at, $t$; (2) $x$ is a part of $y$ at $t$; and (3) $x$ overlaps at $t$ everything that is a part of $y$ at $t$.[5]

Intuitively, an organism's instantaneous temporal part at a moment, $t$, is a part of the organism at $t$, which is confined to $t$, and which shares the organism's momentary qualitative profile—its shape, size, weight, and so on—at $t$.

On this picture, a perduring object is exactly located at an extended temporal interval in a way that is analogous to how an object with proper spatial parts is exactly located at an extended spatial region. Just as a composite object is spatially extended by having different spatial parts at different regions, a perduring object is temporally extended by having different temporal parts at different moments. I take this to be the now-standard account of the perdurance intuition.

My formulation of standard perdurance differs from the classical Lewisian formulation: for any continuant $x$, $x$ perdures iff $x$ exists at different moments by having different instantaneous temporal parts at the different moments.[6] How are these formulations related? My formulation of perdurance is an extension of the classical formulation. The classical formulation focuses on the *mereological* aspect of the perdurance intuition: just as spatial composites have different spatial parts at different regions, perdurants have different temporal parts at different moments. But the perdurance intuition also has a *locational* aspect: just as spatial composites are spatially extended, perdurants are temporally extended.[7] The classical formulation of perdurance is silent about the locational aspect. It does not address the issue of how a continuant is exactly located in time. Is a continuant exactly located at an interval, and hence temporally extended? Or is it only exactly located at moments, and hence temporally unextended? (There are more options.) To say that an object exists at different moments, in the ordinary sense of existing at a moment, is not to say that the object is temporally extended. A continuant's existence at different moments—that is, its persistence—is meant to be a neutral starting point. Once the question of an object's exact temporal location is raised, the locational aspect of the perdurance intuition comes into view. My formulation of perdurance adds the locational aspect

[5] This is a slightly modified version of Sider's widely accepted definition (2001: 59). Where Sider uses 'exists at $t$', I use 'is exactly located at $t$'. Since instantaneous temporal parts feature in the standard perdurantist account of what it takes to exist at a time, in the ordinary sense of existence at a time, this ordinary notion must not be used in (TP). For it would be circular to explain existence at a time in terms of this very notion. Thus, a more basic notion is required, in order to define temporal parthood. Exact temporal location is a natural candidate in a perdurantist setting. The generalization of (TP) to include extended temporal parts is straightforward.

[6] See Lewis (1986: 202). On this formulation, 'perdurance' stands for a certain non-causal explanation of persistence. On a non-explanatory alternative that can also be found in the literature, perdurance concerns the mere existence of temporal parts of objects. See Wasserman (2016) for a discussion of this distinction and references. The explanatory approach seems to be the approach that is most widely accepted today.

[7] The locational aspect is discussed, inter alia, in Gilmore (2006) and Sattig (2006). See Gilmore (2013: Sect. 6) for further references.

of the perdurance intuition to the classical mereological aspect in a straightforward way: just as spatial composites are exactly located at a spatially extended region by having different spatial parts at different subregions of the latter, perdurants are exactly located at a temporally extended interval by having different temporal parts at different moments in the interval.

The aim of this paper is to criticize this mereological-cum-locational sharpening of the perdurance intuition in light of the distinction between mereologically structured and unstructured objects. In Sect. 2, this distinction will be introduced in a purely spatial context. In Sect. 3, the distinction will be applied to continuants. It will be shown that while the mentioned account of perdurance captures the targeted space-time analogy for unstructured objects, it fails to capture the space-time analogy for temporally and spatially structured objects.

## 2 Mereologically structured and unstructured objects

Suppose that a given material object is composed of some parts. How are these parts related to the composite's nature, its identity? How do these parts contribute to what the object is? Two views will be distinguished: the view of objects as mereologically *unstructured* and the view of objects as mereologically *structured*. In this section, the two views will be introduced by application to cases in which the composite is considered at a single moment only, and hence the composite's temporal profile will be ignored.[8] In the next section, the two views on mereological structure will be applied to persisting wholes.

Suppose that a human organism, *o*, has, inter alia, a heart *a* and a brain *b* as proper parts (at some moment). How are *a* and *b* related to *o*'s nature, or identity? On the view of composite objects as *unstructured*, it is essential to *o* that *a* and *b* be parts of *o*. The nature of *o* depends on *which* objects *o* has as its parts, but it does not depend on the parts' intrinsic profiles or on the parts' arrangement. Part *a* falls under the sortal concept *human heart*, and part *b* falls under the sortal concept *human brain*. If organism *o* is unstructured, the fact that *a* is a heart and the fact that *b* is a brain make no contribution to *o*'s nature. Nor do any non-mereological relations or functions or operations involving *a* and *b*—such as relations of physical bonding or biological functions of oxygen distribution—make any contribution to *o*'s nature.

By contrast, on a typical view of composite objects as *structured*, it is essential to *o* that its parts have certain sortal profiles, and that its parts be arranged in a certain way. What sortal profiles the parts must possess and which arrangement they must exhibit depends on what *o* is like essentially—that is, *o*'s essence, or identity, encodes a certain qualitative mereological profile. Suppose that *o* is a human organism, and that being a human organism is *o*'s essential kind. In this case, for *a* and *b* to be parts of *o*, they must belong to kinds that contribute to making *o* a human organism—such as the kind of being a heart and the kind of being a brain—and they must be arranged in a way that likewise contributes to making *o* a human organism. I shall just say that

[8] Cf. Sattig (2021b: ch. 1).

the parts of *o* must be arranged human-organism-wise. That it is essential to *o* that its parts have certain qualitative properties and relations makes *o* a structured object.[9]

Some friends of structured objects illustrate their view in terms of *mereological slots*. A composite material object, *o*, is structured by a certain arrangement of *slots* that are *filled by* other objects.[10] In what follows, I shall adopt the slot-idiom for the purpose of describing the mereological structure of material objects in a vivid and accessible way. While one might consider the figurative slot-idiom too impressionistic to feature in the ultimate characterization of an object's mereological structure, it is well suited for the purpose of exploring and illustrating basic connections between mereological structure and persistence.

Given the slot-idiom, the idea that whether some *x* is a part of *o* depends on what kind of object *x* is can be characterized as follows: all slots of an object are kind-sensitive—that is, a filler of a K-slot, for some kind K, must fall under K. Moreover, the idea that whether some objects, the *x*s, compose *o* depends on how the *x*s are arranged can be characterized in terms of slots: *o*'s slots combine to constitute *o*'s slot-structure. The latter has also been described as *o*'s *form*, and the plurality of objects that fill *o*'s slots as *o*'s *matter*.[11] The view of composite objects as structured can thus be labelled a *hylomorphic* account of objects.

Two further distinctions will be mentioned briefly, in order to give the notion of mereological structure a bit more shape. First, if our organism *o* has a *pure* mereological structure, then it is not essential to *o* that the individual heart *a* and the individual brain *b* be parts of *o*. Likewise for all other parts of *o*. *Which* objects are parts of *o* makes no contribution to *o*'s nature. If, by contrast, an object has an *impure* mereological structure, then some or all of its particular parts are essential to it. In slot-terms, the object's slot-structure is impure when some or all of its slots are 'reserved slots'—that is, when some or all slots can only be filled by particular objects. The ordered pair $<a, b>$ might be viewed as having an impure slot-structure. The pure-impure-distinction is relevant for questions of change and modal variation. Those who view an organism as a structured object typically consider the organism as a purely structured object, since the organism could have a heart other than *a* and a brain other than *b* as parts. In what follows, I shall only consider cases of pure mereological structure, since the most familiar cases of structured object are ordinary macroscopic composites, such as organisms, and they are best conceived of as purely structured.[12]

Second, the view of objects as structured is typically accompanied by the claim that an object's parts are ordered hierarchically—the claim, in other words, that an object has *immediate* parts and *mediate* parts. In the case of a human organism, one might say that the heart and the brain are among the organism's immediate parts, whereas the cells in the heart and those in the brain are among the organism's mediate

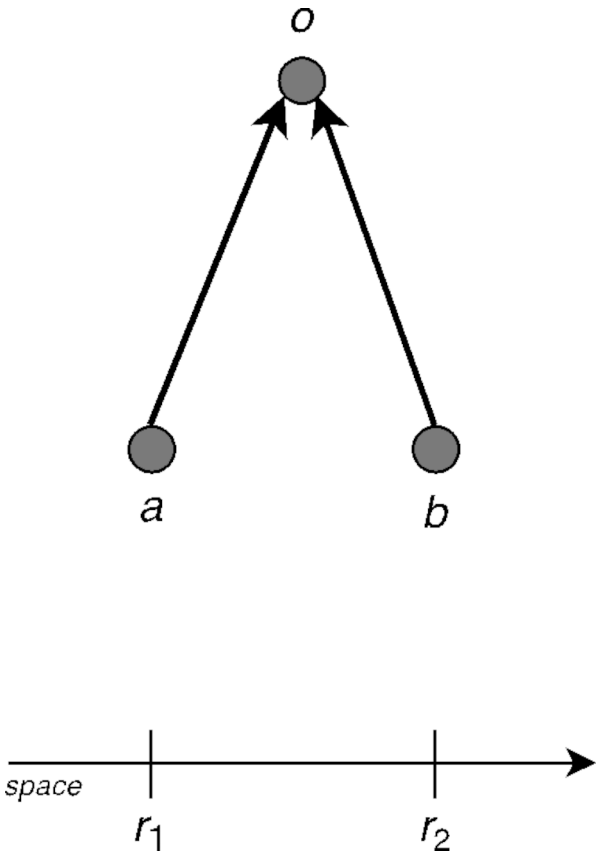
[9] For this sort of picture of mereological structure, see, inter alia, Fine (1999, (2010; Koslicki (2008, (2018; Sattig (2015, 2021a, b).

[10] See, inter alia, Bennett (2013); Koslicki (2008); Sattig (2021a, b).

[11] The notion of matter is not uniformly understood in this way.

[12] The main point to be made in this paper could also be based on the notion of an impurely structured object.

**Fig. 1** An unstructured object



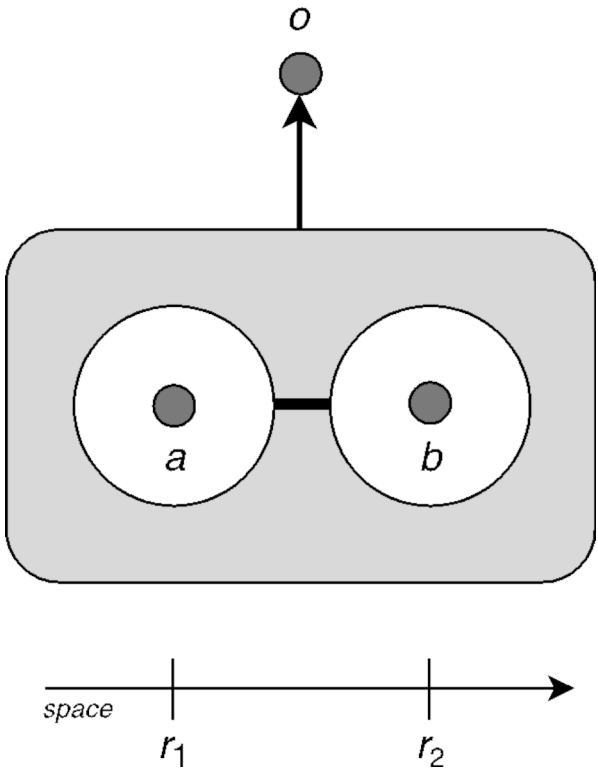

parts. This mereological hierarchy can be characterized in slot-terms as well: *o* has *immediate* slots and *mediate* slots. The filler of the organism's immediate heart-slot and the filler of the organism's immediate brain-slot both have their own slots. The fillers of these may have further slots, and so on. In this case, only *o*'s immediate slots are encoded in *o*'s nature, whereas *o*'s mediate slots are not. For simplicity, only immediate slots of objects will be considered henceforth.

I shall illustrate unstructured and structured objects by means of the following graphic tools. Figure 1 is an illustration of an unstructured object, *o*, with two essential parts, *a* and *b*. Upward arrows pointing to '*o*' indicate a contribution to the nature, or identity, of *o* by a proper part of *o*.

Figure 2 is an illustration of a structured object, *o*, with two slots filled by *a* and *b*, respectively. The grey area stands for *o*'s slot-structure and the white areas inside of the grey one for slots of *o*. The line connecting the two white circles stands for the arrangement of parts encoded in *o*'s slot-structure. The upward arrow pointing to '*o*' indicates a contribution to the nature of *o* by *o*'s slot-structure.[13]

[13] For a similar figure, see Sattig (2021b: 15).

**Fig. 2** A structured object




There are many types of mereological structure.[14] Here I am primarily concerned with spatial and temporal mereological structure. In the remainder of this section, I shall consider the spatial profile of an ordinary spatial composite and contrast the view of such an object as completely, and hence spatially, unstructured with the view of the object as spatially structured. This comparison will later guide my discussion of temporal structure.

An ordinary composite object, such as a human organism, is spatially extended. That is, it is exactly located at an extended spatial region. Suppose that organism *o* is exactly located at a spatial region that includes subregions $r_1$ and $r_2$. Suppose, moreover, that *o* has proper parts *a* and *b*, which are exactly located at $r_1$ and $r_2$, respectively. These assumptions are neutral with respect to whether *o* is spatially unstructured or structured.

How does *o* get to be spatially extended if *o* is unstructured, and how does *o* get to be spatially extended if *o* is spatially structured? Importantly, the unstructured case and the spatially structured case come apart on this issue concerning the ground of spatial extension. In the unstructured case, the natural and widely accepted account of a composite's spatial extension is the one introduced in Sect. 1. According to the latter, organism *o*'s being exactly located at an extended region derives from facts about which proper parts *o* has and at which regions these proper parts are exactly

[14] See Fine (2010).

located. In general, necessarily, for any composite $x$ and any extended region $r$, $x$ is exactly located at $r$, because (i) $x$ is composed of non-identical parts $p_1 \ldots p_n$, (ii) $p_1 \ldots p_n$ are exactly located at non-identical regions $r_1 \ldots r_n$, respectively, and (iii) $r_1 \ldots r_n$ add up to $r$. On this picture, the organism is stretched out through space, in virtue of having different spatial parts at different spatial regions.

If a composite is conceived of as spatially structured, by contrast, then the composite's spatial extension does not have this source. It is not the case that, necessarily, a spatially structured object is stretched out through space, in virtue of having different spatial parts at different regions. This divergence concerning spatial extension is important for what follows. I shall illustrate it by means of the following example.

Suppose that a common spatially extended diamond, $d$, is, by its nature, composed of carbon atoms that are arranged tetrahedrally. That is, (at each moment) $d$ has different carbon-atom-slots that jointly encode a tetrahedral arrangement. Since $d$'s slot-structure encodes a certain pattern of spatial distance-relations between carbon atoms, $d$ is a spatially structured object. Now suppose that $d$ exists in an exotic world, in which carbon atoms are exactly located at multiple spatial regions at any moment. Suppose, moreover, that a single multi-located carbon atom, $c$, fills every carbon-atom-slot of $d$, at a given moment, as illustrated in Fig. 3.

This is a possible scenario for a spatially structured diamond.[15] How is diamond $d$ spatially extended in this case? Does $d$'s exact location derive, by the standard aggregative scheme, from facts about which things $d$ has as proper parts and facts about where these things are exactly located? The point of the standard scheme is that a composite gets its exact extended location by means of composition from a plurality of smaller things with different exact locations: by fusing a plurality of things that are exactly located at non-identical regions $r_1 \ldots r_n$, respectively, we get a thing, the fusion, that is exactly located at the sum of $r_1 \ldots r_n$. Diamond $d$ is not composed of a plurality of proper parts. It has but a single proper part, $c$ (ignoring, for simplicity, any parts of $c$). Therefore, that $d$ has an exact diamond-shaped location is not a result of fusing different things that are exactly located at different regions that add up to a diamond-shaped region. The standard scheme does not apply here. It is not the case that the diamond has an extended exact location in space, in virtue of having different spatial parts at different regions.

Moreover, while $c$ is exactly located at multiple carbon-atom-shaped regions, and while these regions add to up to a diamond-shaped region, $c$ is not exactly located at this diamond-shaped region. For a thing $x$'s exact location at regions $r_1 \ldots r_n$ does not necessitate $x$'s exact location at the sum of $r_1 \ldots r_n$.[16] Of course, $c$ 'fills up' the sum of $r_1 \ldots r_n$, and hence $c$ is located at this sum, in some sense of 'location'. But this is not exact location. Hence, it is not the case that the diamond has an extended exact location because its sole spatial part has this exact location.[17]

While the scenario of the spatially extended diamond with a single spatial part is possible if the diamond is spatially structured, the scenario is impossible if the dia-

[15] Given that the possibility of an object's having multiple exact locations is accepted. See Gilmore (2013: Sect. 6) for a discussion of multilocation and references.

[16] See, inter alia, Gilmore (2013: Sect. 6) for a statement of this widely accepted assumption.

[17] See Parsons (2007) for an overview of different notions of location.

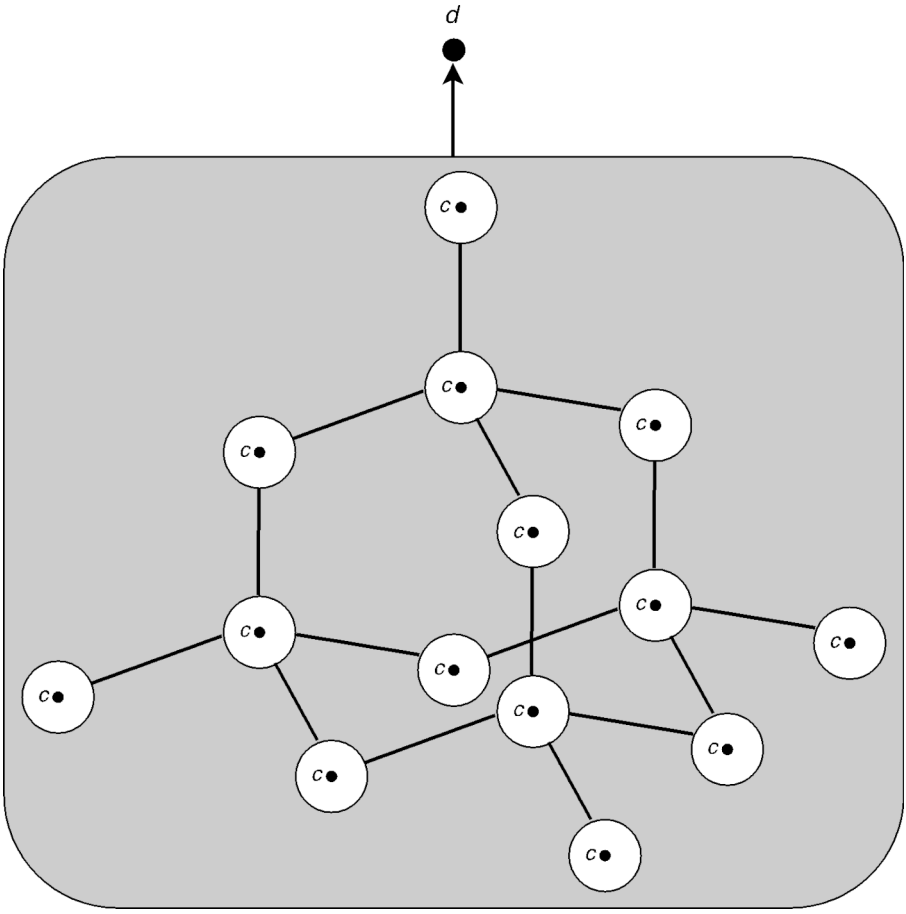



**Fig. 3** A spatially structured diamond with a single spatial part

mond is unstructured. Since an unstructured composite gets its exact spatial location by means of composition from a plurality of things with different exact locations—along the lines of the standard scheme—there cannot be an unstructured spatially extended diamond that is composed of a single multi-located carbon atom. If our diamond, *d*, is conceived of as an unstructured object that has carbon atom *c* as its single part (ignoring any proper parts of the carbon atom), then *d* ends up being numerically identical with *c*, and hence *d* is exactly located at each of the spatial regions at which *c* is exactly located. That is, *d* is spatially multi-located at a number of regions, rather than being uniquely located at the sum of these regions.

The case of the diamond motivates a distinction between different accounts of the spatial extension of composites, depending on whether composites are conceived of as unstructured objects or whether they are conceived of as spatially structured objects. Since the standard scheme of spatial extension does not work for spatially structured composites, I suggest the following alternative scheme: a spatially structured composite is spatially extended, because it has a *spatially non-local* slot-struc-

ture. That is, a composite's immediate slot-structure requires its fillers to have certain positive spatial distances to each other—the composite's slot-structure encodes certain cross-spatial relations (as illustrated in Fig. 2 by the horizontal line connecting the two slot-circles). As I shall put it, a spatially structured composite has different spatial slots at different regions. And each of these slots requires its filler to be exactly located at the associated region.[18]

Following this rough scheme, our diamond is spatially extended, because it has a spatially non-local slot-structure—more specifically, its immediate slot-structure encodes a tetrahedral arrangement of carbon atoms across space. Likewise, a human organism is spatially extended, because it has a spatially non-local slot-structure—more specifically, its immediate slot-structure encodes an organism-wise arrangement of human organs across space.

## 3 Perdurance and mereological structure

The distinction between mereologically structured and unstructured objects will now be applied to continuants. I will consider three types of case, and I will ask about each case whether the featured continuant perdures. While the standard account of perdurance classifies the first and second case correctly, it misclassifies the third case. The latter features temporal mereological structure that is analogous to the spatial mereological structure discussed in the previous section.

### 3.1 First case: a persisting organism without structure

Suppose that $o$ is a persisting mereologically unstructured human organism. The nature of $o$ depends on which objects $o$ has as its proper parts. But $o$'s nature neither depends on how the parts are arranged—for instance, spatially, temporally or functionally—nor on what intrinsic profiles the parts possess. Among $o$'s proper parts are instantaneous temporal parts, as defined in (TP) in Sect. 1. Suppose that $o$ persists from moment $t_1$ to moment $t_2$. Moreover, $o$ is exactly temporally located at the interval $[t_1, t_2]$, and hence $o$ is temporally extended. The temporal part of $o$ at $t_1$ is $o_1$, and the temporal part of $o$ at $t_2$ is $o_2$. While $o$ is neither exactly located at $t_1$ nor at $t_2$, $o_1$ is exactly located at, and only at, $t_1$, and $o_2$ is exactly located at, and only at, $t_2$. Finally, $o_1$ is composed, inter alia, of heart-stage $a_1$, which is exactly located at, and only, at $t_1$, and of brain-stage $b_1$, which is also exactly located at, and only at, $t_1$. This allows us to say, in ordinary parlance, that $o$ has a heart and a brain at $t_1$. Analogously, $o_2$ is composed, inter alia, of heart-stage $a_2$, which is exactly located at, and only, at $t_2$, and of brain-stage $b_2$, which is exactly located at and only at, $t_2$. This allows us to say, in ordinary parlance, that $o$ has a heart and a brain at $t_2$. Since $o$ is an unstructured

[18] It would be implausible to hold that mereological slots are sensitive to particular spatial regions, since any ordinary composite could be located at a different region than the one at which it is actually located. For simplicity, I shall speak of an object as having a slot at a specific spatial region (at a moment), while this region is not encoded in the object's slot-structure. Present purposes do not demand addressing this aspect of the slot-idiom. As pointed out earlier, the idiom is here employed as a mere exploratory and illustrative tool.

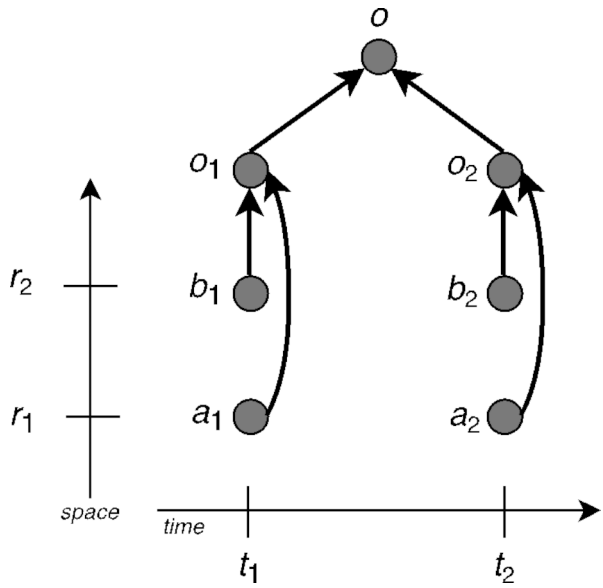



**Fig. 4** A persisting organism without structure

object, all of these parts—$o_1$, $o_2$, $a_1$, $a_2$, $b_1$, and $b_2$—are essential to $o$. This case is illustrated in Fig. 4.

This is a classical case of a perduring object. The core of perdurance is a space-time analogy: a perduring object is extended in time in a way that is analogous to how a composite object is extended in space. Recall from Sect. 2 how an unstructured composite object gets to be spatially extended. Organism $o$ is spatially extended—that is, $o$ is exactly located at an extended spatial region. Moreover, $o$ gets to be exactly located at this extended region by having different spatial parts that are exactly located at different spatial subregions of the larger region, respectively. Analogously, in the present case, $o$ is exactly located at the interval $[t_1, t_2]$—and hence $o$ is temporally extended. Moreover, $o$ gets to be temporally extended by having different temporal parts that are exactly located at different moments in the interval, respectively. Owing to this analogy between the spatial extension of an unstructured organism and the temporal extension of an unstructured organism, we expect that a temporally extended unstructured organism is a perduring object. And the standard account of perdurance satisfies this expectation. It classifies $o$ correctly.

### 3.2 Second case: a persisting organism with a temporally local structure

Suppose that $o$ is a human organism. Let us assume that the sortal concept *human organism* has *temporally local* conditions of application—that is, conditions that an object satisfies at a moment. Schematically, an object, $o$, is a human organism at a moment, $t$, iff $o$ has the power to sustain human life at $t$.

Organism $o$ is a structured object. It has an immediate slot-structure. Assuming that it is essential to $o$ that it be a human organism, $o$'s immediate slot-structure encodes the conditions for being a human organism (see Sect. 1). Since these conditions are temporally local, $o$'s immediate slot-structure is temporally local. And since

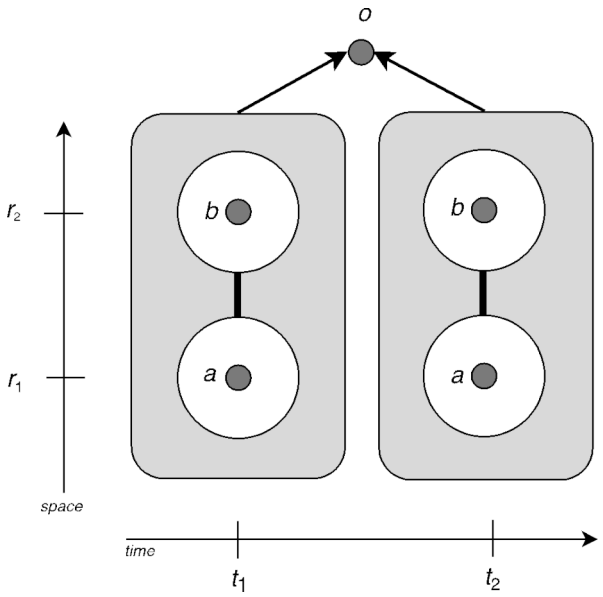



**Fig. 5** An organism with a temporally local structure

*o*'s immediate slot-structure is essential to *o*, *o* possesses the same immediate slot-structure at each moment of *o*'s life. Schematically, at each moment at which *o* exists, *o*'s invariant immediate slot-structure requires its fillers jointly to have the power to sustain human life.

Assuming that organism *o* has a temporally local, invariant slot-structure, suppose that *o* has, inter alia, the same heart-slot and the same brain-slot at $t_1$ and $t_2$. Moreover, *o*'s immediate slots are, at $t_1$ and $t_2$, arranged in a way that realizes the power to sustain human life. Thus, *o* has a certain temporally local but spatially non-local mereological structure. Suppose, moreover, that *o*'s heart-slot is filled by *a* at both $t_1$ and $t_2$, while *o*'s brain-slot is filled by *b* at both $t_1$ and $t_2$. Notice that both of these slots could be filled by other objects at the two moments. As a consequence of these slot-assignments, *a* is *o*'s heart and *b* is *o*'s brain at $t_1$ and $t_2$. This simple slot-structure is illustrated in Fig. 5.

Organism *o* persist from $t_1$ to $t_2$. How is *o* related to $t_1$, $t_2$, and the interval they span, in terms of exact location? First, *o* is exactly located at both $t_1$ and $t_2$—that is, *o* temporally multi-located. Second, *o* is not exactly located at the interval $[t_1, t_2]$—that *o* is exactly located at each moment in $[t_1, t_2]$ does not entail that *o* is exactly located at the sum of these moments (see Sect. 2). Thus, *o* is not temporally extended. How is *o* related to $t_1$, $t_2$, and the interval they span, in terms of temporal parthood? Since *o* is not temporally extended, the standard scheme of temporal extension via temporal parts does not apply to *o*. Correspondingly, *o* does not exist at different moments—in the ordinary sense of existing at a moment—by having different temporal parts at the different moments. For *o* does not need a temporal part to exist at a moment. Rather, for *o* to exist at $t_1$ and $t_2$ just is for *o* to be exactly located at $t_1$ and $t_2$. This is a clear case of an object that is not spread out through time in a way that is analogous to the way a composite object is spread out through space. Owing to this disanalogy, we

expect *o* to be a non-perduring object. And the standard account of perdurance classifies *o* as such.

### 3.3 Third case: a persisting organism with a temporally non-local structure

Suppose that *o* is a human organism. While in the second case it was assumed that the sortal concept *human organism* has temporally local conditions of application, let us now assume that this concept has *temporally non-local* conditions of application instead. Thus, suppose that for an object to be a human organism, it is not enough for it to have the power to sustain human life at a moment. For an object to be a human organism, it must actually sustain human life—it must be alive. It must have a heart that does some beating and a brain that does some thinking. Since being alive takes time, these conditions cannot be satisfied at a moment. They can only be satisfied over a period of time. No object that is confined to a single moment is a human organism. Furthermore, let us assume that these temporally non-local conditions of application are *maximal*: for an object to be a human organism, it must satisfy these conditions throughout its life. For *o* to be a human organism, *o*'s organs, cells, and so on, must perform human-life sustaining biological functions throughout *o*'s life.

Organism *o* is a structured object. It has an immediate slot-structure. Assuming that it is essential to *o* that it be a human organism, *o*'s immediate slot-structure encodes the conditions for being a human organism. Since these conditions are temporally non-local and maximal, *o*'s slot-structure is temporally non-local and maximal.[19] By the temporal non-locality of *o*'s immediate slot-structure, *o* does not possess the same immediate slot or slots at each moment of its life. Rather, *o* has different immediate slots at different moments.[20] Let us say, for illustration, that *o* has different heart-slots at different moments, and that *o* has different brain-slots at different moments. Moreover, these different slots are linked by certain cross-temporal relations. What constraints are imposed by these slots on their fillers? Schematically, there are cross-temporal constraints concerning K-slots at different moments, for the same kind K. Intuitively, the constraint imposed by the temporal sequence of heart-slots is that its respective fillers be the subjects of instantaneous states of affairs that jointly form a heart-beat. Furthermore, there are cross-temporal constraints concerning K-slots at different moments, for different Ks. Intuitively, there is an overall constraint that the fillers of the entire slot-structure be the subjects of instantaneous states of affairs that jointly form a human life. Organism *o*'s immediate slot-structure imposes processual

[19] Object-sortals that have temporally non-local conditions of application share this property with typical event-sortals, such as *concert*, and typical process-sortals, such as *acceleration*. Being a concert and being an acceleration take time. If being a concert is part of a concert's nature, then a concert might plausibly be conceived of as having a temporally non-local slot-structure. Likewise for processes. This extension of the present considerations to events and processes strikes me as philosophically promising. But material objects are not events, nor are they processes. And the now-classical debate about persistence focuses on material objects. Therefore, I won't digress any further.

[20] An organism's immediate cross-temporal slot-structure does not encode a specific sequence of moments, since any organism could exist at different moments than the ones at which it actually exists. Accordingly, the notion of having a slot at a moment is not to be taken as a theoretical primitive. As in the spatial case addressed in Sect. 2, the notion of having a slot at a moment serves an illustrative purpose only.

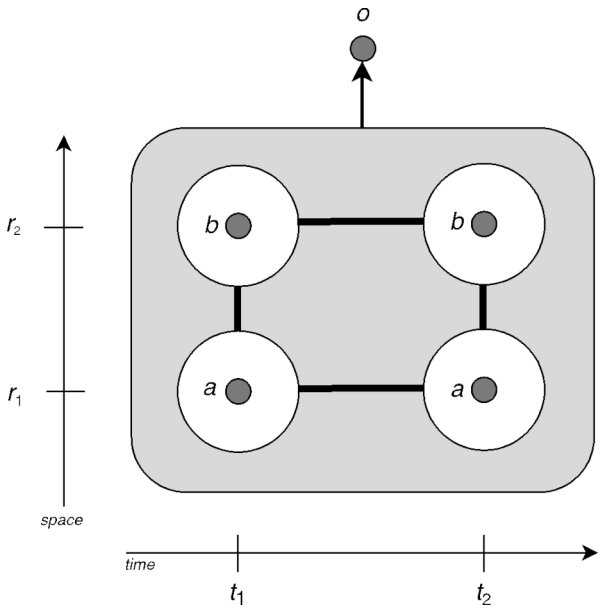



**Fig. 6** An organism with a temporally non-local structure

constraints upon its fillers. Thus, *o* has an immediate slot-structure that is temporally as well as spatially non-local.

To give a slot-assignment, let us say that the heart-slot that *o* has at $t_1$ is filled by *a*, and that the brain-slot that *o* has at $t_1$ is filled by *b*. Suppose, further, that *a* also fills the different heart-slot that *o* has at $t_2$, and that *b* also fills the different brain-slot that *o* has at $t_2$. Note that this slot-assignment is meant to leave open whether heart *a* and brain *b* themselves have a temporally local or a temporally non-local slot-structure.[21] The specified slot-structure is illustrated in Fig. 6.

How does *o* persist from $t_1$ to $t_2$? First of all, *o* is temporally extended. It is exactly located at the interval $[t_1, t_2]$, while *o* is neither exactly located at $t_1$, nor at $t_2$. How does *o* get to be temporally extended? The answer is that *o* has a temporally non-local slot-structure. That is, *o* has different immediate slots at different moments. This structural mode of temporal extension does not rely on temporal parts. For illustration, suppose that all of the fillers of *o*'s immediate slots at $t_1$ and $t_2$, including heart *a* and brain *b*, are exactly located at $t_1$ and $t_2$. (The locational profiles of *a* and *b* were initially left open.) Then *o* lacks any parts at $t_1$ and at $t_2$ that are confined to these moments, and hence *o* lacks any instantaneous temporal parts at $t_1$ and $t_2$, by definition (TP). Thus, it is not the case that *o* is temporally extended, in virtue of having different temporal parts at different moments. Hence, the organism does not perdure, by the standard account of perdurance. Notice that this last scenario is a temporal analogue of the spatial scenario of the diamond of Sect. 2. The latter illustrates that a composite's structural mode of spatial extension does not rely on spatial parts. Since the diamond does not have different spatial parts at different regions, the diamond

[21] A heart-slot at a moment, *t*, thus requires merely that its filler exist at *t*, rather than that its filler be exactly located at *t*.

does not get its exact spatial location by composition. Analogously, since the organism does not have different temporal parts at different moments, the organism does not get its exact temporal location by composition.[22]

The classification of the present case as a case of non-perdurance is a misclassification. The reason is that the human organism in this case is spread out through time in a way that is analogous to how the organism is spread out through space, and hence that this organism deserves to be classified as perduring, by the perdurance intuition. That this space-time analogy obtains can be shown as follows.

The organism of the third case, $o$, is a spatially extended object with a spatial structure. It is, at $t_1$, exactly located at an extended spatial region that includes $r_1$ and $r_2$ (see Fig. 6), while $o$ is neither exactly located at $r_1$ nor at $r_2$. How is $o$ spatially extended, at $t_1$? As I suggested in Sect. 2, a spatially structured object is spatially extended, in virtue of having a spatially non-local slot-structure—that is, a slot-structure that encodes cross-spatial relations. Thus, $o$ is spatially extended, at $t_1$, in virtue of having different slots at different regions at $t_1$. Moreover, it is not the case that $o$ is spatially extended, at $t_1$, in virtue of having different spatial parts at different regions at $t_1$. All that $o$ needs for being spatially extended at $t_1$ is a spatially non-local slot-structure.

Now, the structured organism of the third case is temporally extended across $[t_1, t_2]$ in a way that is analogous to how it is spatially extended at $t_1$ and $t_2$. In this case, $o$ is temporally extended, in virtue of having a temporally non-local slot-structure—that is, a slot-structure that encodes cross-temporal relations. Somewhat more specifically, $o$ stretches across the interval $[t_1, t_2]$, in virtue of having different human-organism-wise arranged slots at different moments in the interval. Moreover, $o$ is not exactly located at $[t_1, t_2]$, in virtue of having different temporal parts at different moments in $[t_1, t_2]$. All that $o$ needs for being temporally extended is a temporally non-local slot-structure. There is clearly a tight analogy with the spatial case. Thus, if we let the space-time analogy at the heart of the perdurance intuition guide us, then $o$ should be characterized as perduring.

The standard account of perdurance is not misguided. It is just limited. It is limited because it is made for unstructured objects only. And for them the formulation works just fine. An unstructured object is spatially extended (at a moment), in virtue of having non-identical spatial parts with different spatial locations. Assuming that this is how spatial extension of spatial composites works, an unstructured object is space-like temporally extended, in virtue of having non-identical temporal parts with different temporal locations. In short, the standard conception of space-like temporal extension takes as its starting point the way in which unstructured composites are spatially extended.

Spatially structured composites are spatially extended in a way that differs substantially from the way in which unstructured composites are spatially extended. Accord-

[22] Nor do the diamond and the organism inherit their spatial and temporal extension, respectively, by straightforward transferal of exact location from their parts. Since the diamond's only proper part is exactly located at multiple carbon-atom-shaped regions, without also being exactly located at the diamond-shaped sum of these regions, the diamond's exact diamond-shaped location is not an exact spatial location of its proper part. Analogously, since all of the organism's proper parts are exactly located at each moment in $[t_1, t_2]$, without also being exactly located at $[t_1, t_2]$, the organism's exact temporal location is not an exact temporal location of its proper parts.

ingly, there is a way for a structured object to be space-like temporally extended, which differs substantially from the way in which an unstructured object is space-like temporally extended. The two different kinds of perdurance may be summarized as follows:

> *Perdurance for unstructured objects*
> An unstructured perduring object is temporally extended by having different temporal parts at different moments, just as an unstructured composite object is spatially extended by having different spatial parts at different regions.

> *Perdurance for structured objects*
> A temporally structured perduring object is temporally extended by having a temporally non-local mereological structure—by having different temporal slots at different moments—just as a spatially structured object is spatially extended by having a spatially non-local mereological structure—by having different spatial slots at different regions.

I conclude that if we take spatial and temporal mereological structure of objects seriously, then we must transgress the bounds of the standard account of perdurance.[23]

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