Chapter 14
Temporal Parts and Spatial Location

Damiano Costa

Abstract The literature offers us several characterizations of temporal parts via spatial co-location: According to these accounts, temporal parts are roughly parts that are of the same spatial size as their wholes. It has been argued that such definitions fail with entities outside space. The present chapter investigates the extent to which such criticism works.

Keywords Temporal parts · Spatial location · Events · Four-dimensionalism · Perdurance

14.1 Introduction

The temporal parts of an entity—according to current vulgate—incorporate 'all of that entity' for as long as they exist (Heller 1984; Sider 2001; Olson 2006). For example, a temporal part of Sam incorporates 'all of Sam' for as long as it exists. One immediate consequence of this fact is that some 'smaller parts' of Sam, like his brain and hearth, do not count as *temporal* parts of Sam, because they do not incorporate 'all of Sam' at a certain time.

To capture this, a suitable definition for temporal parts must exclude such 'smaller parts'. In this regard, two approaches have been put forward, a mereological one (Simons 1987; Sider 1997; Parsons 2007) and a spatial one (Thomson 1983; Heller 1984; McGrath 2007). On the one hand, the mereological approach says that such 'smaller parts' of Sam are not temporal parts because they do not overlap every part of Sam at a certain time. On the other hand, the spatial approach roughly says that such 'smaller parts' of Sam are not temporal parts because a temporal part is *of the same spatial size* as its whole for as long as that part exists.

Recently, some philosophers have attacked the spatial approach. In particular, Sider (2001, p. 59) blamed it for failing with entities outside space.[1] The reason for

[1] It is worth noting that there is a failure because on one hand there is a suggested formal definition of temporal parts, on the other, there is an already established intuitive notion and several

D. Costa (✉)
University of Geneva, Geneva, Switzerland
e-mail: Damiano.Costa@unige.ch

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such a criticism is easy to guess: How can an entity without any spatial size be of the same spatial size as something else?

Nevertheless, this criticism is less immediately conclusive than it would seem to be at first sight. For there are several ways of formalizing the spatial approach. And each way fails exclusively under specific ontological assumptions that are, as we shall see, anything but innocent, e.g. that there are entities that are partly inside and partly outside space.

In the course of the chapter, I shall discuss two versions of the spatial approach, respectively called *strong* and *weak*.[2] In analysing both versions, I will pursue the following strategy. First, I shall define temporal parts via one of the two versions of co-location. Second, I shall present systems in which the definition fails. The construction of the systems will reveal the ontological assumptions needed to rule out the spatial approach.

What does it mean for a definition to fail? Let us say that a definition for temporal parts fails in a system S just in case it does not capture our intuition about what the temporal parts occurring in S are; and that, a definition fails *tout court* just in case it fails in a system S and the system is realistic, i.e. the structure of S is isomorphic to the structure of the actual world.

14.2 Synchronic Parts

I shall begin by making the following point. The original aim of the spatial and mereological approaches is to exclude ‘smaller parts’ from being temporal parts. What are such ‘smaller parts’? In order to answer this question, it is worth introducing the notion of *synchronic* part (aka *temporary* part, Simons 1987). I assume that ‘smaller parts’ mentioned before are nothing but synchronic parts.

A synchronic part is a part in time cut along a dimension that is not temporal. A classical example of synchronic part is a spatial part, where a spatial part is in time and cut along spatial dimensions. A basic characterizing feature of synchronic parts is the following one: If x is a synchronic part of y at t, then there are other synchronic parts of y at t (Simons 1987). Let us focus again on the example of spatial parts. If y has a spatial part at t, then it has other spatial parts at the same time.

We can formally characterize synchronic parts as follows. Let $t, t', \ldots$ be variables for instants[3] of time, and $l, l', \ldots$ be variables for regions of space. Let $x@t$

paradigmatic examples of temporal parts. The failure consists in the fact that the suggested formal definition does not capture all and only temporal parts. In this sense, the aim of this chapter is different from Parsons’ (2007). Parsons’ aim is to correctly define perdurantism. He wants a definition of temporal part adequate only with respect to this aim, and not (primarily) in comparison with the already established notion of temporal part.

[2] Here ‘weak’ means only that it works in a larger number of systems than the other.

[3] In what follows, I shall focus on *instants*, *instantaneous* locations and *instantaneous* temporal parts. Nevertheless, I shall provide the temporally extended counterparts in footnotes. In the first place, let $T, T', \ldots$ be variables for intervals of time. I shall not consider here what the temporally

mean that x is exactly temporally located[4] at t and $x \wr y$ mean that x is disjoint from y (i.e. it does not overlap y).

Definition 14.1 SP(x, y, t) (x is a synchronic part of y at t)

$$\mathrm{SP}(x,y,t) := x \ll y \wedge x@t \wedge \exists z\left(z \ll y \wedge z@t \wedge z \wr x\right)$$

The temporally extended counterpart would be: $\mathrm{SP}(x,y,\mathrm{T}) := x \ll y \wedge x@\mathrm{T} \wedge \exists z(z \ll y \wedge z@\mathrm{T} \wedge z \wr x)$.

With the formal apparatus introduced in this section, I am also able to formally sketch the standard version of the mereological approach M-TP $:= x \ll y \wedge x@T \wedge \forall z((z < y \wedge z@t) \rightarrow \neg z \wr x)$.

I will call an entity 'thick' just in case it has synchronic parts, otherwise I will call it 'thin'.

14.3 Strong Co-Location

Let @ be a triadic predicate for spatial location at a time:

$x,t@l$ for 'at t x is located at l'

@ is useful in the kind of cases in which we have to distinguish the spatial location of an entity at a time from the spatial location of the same entity at another time, e.g. in the case where we have to distinguish where Sam is now and where Sam was yesterday.

Now, let l be the binary function built on @.[5] Intuitively, this function takes an entity and an instant of time and returns the spatial location of that entity at that time:

$l(x,t)$ for 'the spatial location of x at t'

The first version of the spatial approach simply requires a temporal part to be of the same size of the whole for as long as the part exists (Heller 1984; McGrath 2007). In other words, if x is a temporal part of y at t, then *the spatial location of x and that of y at t must be identical.*[6] Take as a definition of spatial co-location the following one:

extended counterparts would be in the case of time being gunky or in the case of there being extended simples.

[4] Casati and Varzi (1999) and Parsons (2007) offer insightful considerations about location in general. I will not summarize their conclusions here. When I speak of location, I mean Parsons' *exact* location, e.g. the exact temporal location of Bertrand Russell is the interval between his birth (8 May, 1872) and his death (2 February, 1970). It is also worth noting that here I am introducing a triadic *predicate*, a piece of language, and I remain neutral, as much as possible, about the ontological counterpart of this predicate, i.e. I am not introducing a triadic *relation*.

[5] Here, I am assuming that an object has a unique (exact) spatial location at a time.

[6] Philosophers holding a spatial criterion of identity for objects or events could find this claim problematic, but this is a question we shall not consider here.

Definition 14.2 S(x, y, t) (x and y are strongly spatially co-located at t)

$$\mathrm{S}(x,y,t) := l(x,t) = l(y,t)$$

The temporally extended counterpart would be $\forall t(t \ll \mathrm{T} \rightarrow (l(x, t)=l(y, t)))$.

At this point, we can attempt to give a first formal definition of 'temporal part'. Within this framework, proper[7] temporal parts are proper parts that exist at a certain time and are spatially co-located with their wholes. Let ≪ be proper parthood and @ be temporal location.[8]

Definition 14.3 S-TP(x, y, t) (x is a temporal part of y at t)

$$\text{S-TP}(x,y,t) := x \ll y \wedge x@t \wedge l(x,t) = l(y,t)$$

The temporally extended counterpart would be $x \ll y \wedge x@\mathrm{T} \wedge \forall t \left(t \ll \mathrm{T} \rightarrow (l(x,t) = l(y,t))\right)$.

Definition 14.3 is the first definition of temporal parts via spatial location that I shall consider in this chapter. Here is a system in which Definition 14.3 fails (from this point, by 'TP entity' I mean an entity with temporal parts).

S1: TP entities outside space
S1 contains an entity y such that
(1) y is a TP entity
(2) y is outside space

Does Definition 14.3 fail in S1? Let x be a temporal part of y (by (2)). By (2), y has no spatial location, function l is undefined on it and $l(x, t)=l(y, t)$ is meaningless, or false. Therefore, x does not fulfil co-location and cannot be a temporal part, *contra hypothesi*. Definition 14.3 fails in S1, because it does not capture all temporal parts in S1.

Is S1 plausible? In other words, are there TP entities outside space? Candidates include classically mental events (Kim 1966, 1976; Gibbins, 1985), and other events (Price 2008). Another TP entity outside space could be time itself (Sider 2001, p. 59). Take the case where time can be divided into parts. The result of this division should count as a temporal part, because it is a part, it is (trivially) located at a time and includes 'all of time' at that time, i.e. there is not another part of time at that time that is left over. If there are really TP entities outside space, Definition 14.3 fails *tout court*.[9]

[7] In this chapter, I will focus on *proper* temporal parts. In order to get improper temporal parts, it suffices to add the identity case by disjunction (i.e. x is an improper part of y iff x is a proper part of y or x is identical to y).

[8] Because of the significant formal similarities between the spatial and temporal location, I will keep a similar symbol for both. In any case, it is important to recognize the difference between the binary predicate introduced here (temporal location) and the triadic predicate introduced before (spatial location at a time).

[9] There is a second criticism that has been moved against Definition 14.3. The idea is that Definition 14.3 captures also tropes for shapes of objects, which are intuitively not temporal parts (Sider 2001, p. 59).

14.4 Weak Co-Location

The original aim of the spatial requirement is to exclude synchronic parts from being temporal parts. However in some cases this exclusion is superfluous, because there are no synchronic parts at all. Consider time, for example. Plainly, time does not have synchronic parts. Hence, any spatial condition is simply superfluous with time. Let us make the spatial condition irrelevant for entities outside time, and run tests on the definitions we obtain.

In the first place, let us forget about function *l*, and go back to the triadic predicate @. The idea is that *if* an entity is located at place *l* at a time *t,* then its temporal part at *t* must also be located at *l*. In this way, entities outside space trivially fulfil the condition.

Definition 14.4 W(x, y, t) (x and y are weakly spatially co-located at t)

$$\mathrm{W}(x,y,t) := \forall 1\big(y,t@1 \leftrightarrow x,t@1\big)$$

The temporally extended counterpart would be $\forall t(t \ll \mathrm{T} \rightarrow \forall l(y,\ t@l \leftrightarrow x,\ t@l))$.

The definition of 'temporal part' changes consequently. Within this framework, temporal parts are parts located at the same place as their wholes, if the wholes are located at all.

Definition 14.5 W-TP(x, y, t) (x is a W-temporal part of y at t)

$$\mathrm{W}-\mathrm{TP}(x,y,t) := x \ll y \wedge x@t \wedge \forall 1\big(y,t@1 \leftrightarrow x,t@1\big)$$

The temporally extended counterpart would be

$$x \ll y \wedge x@\mathrm{T} \wedge \forall t(t \ll \mathrm{T} \rightarrow \forall l(\mathrm{y},t@l \leftrightarrow x,t@l).$$

Here are two systems in which Definition 14.5 fails.

S2: thick TP entities outside space
S2 contains an entity y such that
(1) y is a TP entity.
(2) y is outside space.
(3) y is thick.

Does Definition 14.5 fail in S2? Let x be a synchronic part of y (by (3)), and thus not a temporal part of y. Since x is a synchronic part of y, x is a part of y and exists at some time t (Definition 14.1). Moreover, by (2) we know that y is outside space,

Nevertheless, according to a plausible principle about parthood, if x is a part of y, then x and y are entities of the same sort. If this is the case, then a trope for shape cannot be, strictly speaking, a part of an object, and therefore does not satisfy the first conjunct of Definition 14.3. The present rejection of this second criticism relies on the assumption that tropes are not objects and objects are not tropes. Whether or not this assumption is true is a question I shall not consider here.

and consequently x is as well.[10] If both x and y are outside space, they are trivially weakly co-located at t (by Definition 14.4). Therefore, x fulfils all conditions of Definition 14.5, and counts as a temporal part of y, *contra hypothesi*. Definition 14.5 fails in S2, because it captures entities that are not temporal parts in S2.

Are there thick TP entities outside space? I will not consider cases of perduring objects outside space. We already said that time is thin. What about events? In general, can events be thick? We should distinguish between coarse-grained and fine-grained conceptions of events. Roughly, coarse-grained events are usually conceived of as regions of space–time. In this case, events can be thick (because space-time seems to be divisible) but can hardly be outside space.

With fine-grained events, it is quite another story. Fine-grained events typically admit co-location, i.e. occurrence at the same place (or to the same subject) at the same time. If there are sums of co-located events, and if their members can be considered parts of them, then also fine-grained events can be thick. Examples are not necessarily bound to arbitrary sum principles because there are plausible examples of thick events. Take the case of a walk, for example. It seems to have parts, i.e. different movements occurring to the left and to the right leg.

Not only must some events be thick in order to validate System 2, these events must also be outside space. This could be an additional problem, because with events outside space we lack one way of distinguishing their parts: the difference of spatial location. In any case, if there actually are thick TP entities outside space Definition 14.5 fails *tout court*.

Let us move to a second system. I shall call 'hybrid' an entity that is partly in space and partly outside it, i.e. if it has synchronic parts that are located in space and synchronic parts that are not located in space.

S3: hybrid TP entities
S3 contains an entity y such that
(i) y is a TP entity.
(ii) y is hybrid.

Does Definition 14.5 fail in S3? First of all, is y itself spatially located (even if partially outside space)? If not, then 14.3 fails in S3 for the same reason it failed in S2: Synchronic parts of y that are outside space are (1) parts of y, (2) exist at a certain time t and (3) are weakly co-located with y at t. Therefore, let us assume that y itself is spatially located. Now, if y is spatially located at t, where is it spatially located? The only reasonable answer is that it is located where its spatial synchronic parts are, i.e. its spatial location at t is the spatial location of the sum of all its spatial synchronic parts at t.

Definition 14.6 y's spatial location at t

$$l(t, y) = l(t, \sigma z(z \ll y \ \& \ \exists l(z, t@l))$$

[10] If I had to justify this implication, I would say that I cannot conceive of an entity that is both outside space and has some parts in space. And even if there were such an entity, it would have some parts outside space. In this case, consider one of these parts outside space and you will find the same problem I am outlining here.

Let *x* be this very mereological fusion. *x* is not a temporal part of *y* at *t,* because it does not incorporate the parts of *y* outside space. Nevertheless, *x* is a part of *y*, and exists at *t*. And by Definition 14.6 it is weakly co-located with *y*. Therefore, *x* fulfils all conditions of Definition 14.5 and counts as a temporal part of *y*, *contra hypothesi*. Definition 14.5 fails in S3 because it captures entities that are not temporal parts in S3.

Are there hybrid TP entities? Again, time must be excluded, because it is entirely outside space. I will give two possible examples of hybrid TP entities: a four-dimensional object and an event, i.e. Sam and his life.

Let us focus on Sam's life. (The case of Sam is analogous.) Sam's life can be seen as the sum of all the events that happened to Sam. Perhaps mental events are outside space, and Sam has a (quite intense, I think) mental life. In this case, Sam's life has parts in space and parts outside space. Moreover, it is plausible that Sam's life has a location, which is the location of the sum of all spatially located parts of Sam's life. In any case, if there actually are hybrid TP entities, Definition 14.5 fails *tout court*.

Under the assumptions of S2 and S3, I think that we can show why *any version of the spatial approach would always fail*. Consider again S2. In order to exclude the problematic cases, we need a condition that is able to make the difference between a thick TP entity outside space and its synchronic parts. But this difference has nothing to do with space. Now consider S3. In order to exclude the problematic cases, we need a condition that is able to make the difference between a hybrid TP entity and the sum of all its spatial parts. But there again, this difference has nothing to do with space. This is why no alternative versions of a spatial condition could ever work.

14.5 Conclusion

In § 3, I concluded that under the ontological assumptions of S1, S2 and S3, the spatial approach is doomed to fail. And, as shown, S1–S3 are anything but ontologically cheap.

At any rate, suppose that a philosopher *x* does not accept the ontological assumptions of S1–3. What conclusions should *x* draw from my discussion? In my opinion, if *x* has another definition that works in all the systems in which 14.5 works, but also in S1–3, then he should prefer this alternative over Definition 14.5. And in fact, the mereological approach offers several definitions that work in any system where spatial definitions work, but also in S1–3. This point provides reasons to prefer the mereological approach over the spatial one.

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