



Parts and Participants

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Abstract

Everyone who endorses the categorial distinction between objects and events must confront a general question: how do these two types of entities relate to one another? Here we are especially interested in what is typically regarded as the basic relational tie between the two, namely, that objects may be said to participate or take part in events, whereas events befall or happen to their participants. The exact nature of this participation relation is philosophically contentious and may depend on how the two categories of objects and events are construed in the first place. Regardless of its metaphysical characterization, however, a number of questions arise concerning its formal features and the general laws that govern its behavior. In particular, since both objects and events can be mereologically structured, we are interested in the formal laws that govern the interaction between participation and parthood. If objects *are* events, as some perdurantists maintain, then participation just *is* parthood. But what if objects and events form genuinely distinct categories? What, then, is the relationship between being part of something and taking part in something?

Keywords Events · Participation · Parthood · Mereology

1 Introduction

It is a common view that the citizens of the world include spatiotemporal particulars of two main kinds. There are objects, broadly construed so as to include rocks and chairs along with animals, plants, molecules, galaxies, etc., and there are events, i.e., things that happen, such as explosions, tornados, and neuron firings along with smiles, walks, fights, speeches, actions of all sorts. Exactly how these two kinds of entities differ is a matter of philosophical debate, and depends greatly on how

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each kind is independently conceived. The traditional picture holds that objects are enduring entities, or, in the classic terminology of Johnson ([61], p. 199), continuants, whereas events are perduring entities, or occurrents.¹ Thus, an object would be wholly present at every moment in which it exists; an event, by contrast, would typically extend over time and would never be present in its entirety at any single moment, unless it occurs instantaneously (as when you spot a typo or touch a flat surface). This traditional picture, however, has several competitors. Most notably, a significant number of philosophers think that objects, too, are perduring occurrents,² just as others maintain that certain types of events, such as activities and on-going processes (e.g. your reading this paper or the moon orbiting around the Earth), are enduring continuants.³ Philosophers in the former camp may even jettison the object/event distinction altogether, confining it to the structure of appearance; as Goodman ([47], p. 285) famously put it, an object would simply be a “monotonous” event, an event an “unstable” object.⁴ So the distinction is not as straightforward as one might initially think, if it holds at all. Still, to the extent that it is accepted, whether in traditional terms or in some other form, it introduces a fundamental ontological dualism. And with the dualism comes a general question: how do objects and events relate to one another?

Here we are especially interested in what is typically regarded as the basic relational tie between the two, namely, that objects may be said to *undergo* or *participate in* or *take part in* events, whereas events *befall* or *happen to* objects. When a candle burns down, it undergoes the burning; when the Texas Western Miners played the Kentucky Wildcats, players from both teams took part in the match; when Brutus stabbed Caesar on the Ides of March, Brutus, Caesar, and a certain dagger all participated in the stabbing; and so on. The exact nature of this participation relation is, again, a matter of philosophical debate, and may depend on how the two categories of objects and events are construed in the first place. But regardless of its metaphysical characterization, a number of questions arise concerning the formal behavior of this relation. The linguistic literature on thematic roles—previously known as thematic relations [50] or deep cases [37]—has gone a long distance towards classifying the many ways in which something can participate in event. For example, with regard to the stabbing of the Ides of March, one would standardly say that Brutus participated as an agent, Caesar as a patient, and the dagger as an instrument ([92],

¹ The distinction is further articulated in Johnson [62], ch. 7. The enduring/perduring opposition comes from Lewis [76], p. 202.

² Early examples include Whitehead [137], Broad [11], and Russell [107], though many others followed suit. For an overview, see Hawley [55].

³ See e.g. Roberts [101], Stout [125, 126], Galton [43, 44], and Kassel [64]. For discussion and developments, see also Steward [123, 124] and the essays in Stout [127].

⁴ This view is shared by other classic authors, such as Broad (an object “is simply a long event”, [11], p. 393) and Quine (“Physical objects [...] are not to be distinguished from events [...] Each comprises simply the content, however heterogeneous, of some portion of space–time”, [98], p. 171). Cf. also Russell [107], p. 284, for whom “It is a mere linguistic convenience to regard a group of events as states of a ‘thing’, or ‘substance’, or ‘piece of matter’”.

ch. 5).⁵ However, such distinctions presuppose that we already know how to identify an event's participants. More generally, they serve only as modifiers of a participation relation that is taken as given and whose behavior—in terms of laws connecting the participants of an event and the event itself—remains unspecified. It is precisely this behavior that concerns us here. In particular, since objects and events may be mereologically structured, we are interested in the laws that govern the interaction between participation and parthood. If objects *are* events, as Goodman and other “perdurantists” hold, then participation just *is* parthood. If you are your life, your head participates in your life insofar as it is part of it. But what are we to say when objects and events form genuinely distinct categories? What is the relationship between *being part of* something and *taking part in* something? And how do the two relations work together? For instance, does participating in an event require participating in every one of its parts? Does it require the participation of every part of the participant? Does it require anything at all, mereologically?

Formally, this project is akin to certain treatments of these relations put forward in the field of applied ontology, particularly in the development of so-called upper-level ontologies (as in Schlenoff et al. [110] or Masolo et al. [81]).⁶ Unlike those treatments, however, ours is not driven by application purposes and aims for greater metaphysical generality, if not outright neutrality. More precisely, we are interested in outlining a formal framework within which theories of various kinds and strengths, and with different commitments, can be formulated and compared. The framework will not be entirely neutral. In particular, we shall treat both parthood and participation as relations governed by classical first-order logic. While this choice is primarily for simplicity, it is not immaterial and could in principle be challenged in both cases.⁷ Apart from this, however, we shall seek to keep our assumptions to a minimum, distinguishing between core axioms and optional principles that could be added to extend the core in consonance with specific philosophical views.

Our hope is that the framework will prove valuable for two reasons—one general and one specific. The general reason is that frameworks of this sort have intrinsic significance. A formal, systematic treatment of a given notion—here: participation—is generally necessary to fully grasp that notion and to distinguish it from related notions. One might even argue that such a formal characterization determines the very meaning of the notion at issue. It is only after such an investigation into its formal profile that one can begin to ask substantive questions about *it* and about *its* interactions with other notions. In other words, the formal framework may be seen as defining the logical space within which substantive questions can then be posed and specific theories formulated. Our general purpose, here, is to provide the framework in the first place.

⁵ For an up-to-date overview of the literature, see Gisborne and Donaldson [46]. Some authors speak explicitly of ‘participant roles’; see e.g. Primus [96].

⁶ Other proposals include Grenon and Smith [49], Schwarz and Smith [113], Robinson [102], Guizzardi et al. [51], and Arp et al. [4]. For a general picture, see Chui and Grüninger [19] and Rodrigues and Abel [103, §4].

⁷ With regard to parthood, see Cotnoir and Varzi [28, ch. 6] for an overview of the issues.

More specifically, we also hope that the formal treatment of the participation relation presented here will prove valuable in shedding new light on substantive metaphysical issues. While a comprehensive discussion of such insights deserves independent scrutiny and must await another occasion, we highlight some of them throughout the paper. These include, but are not limited to, the following:

- (a) *Event vs. universal participation*: To what extent do the formal features of the event participation relation apply to other relations sometimes grouped under the same heading, beginning with the relation of participation between particulars and universals⁸ that is so central to Platonic and Aristotelian metaphysics.⁹
- (b) *Metaphysics of causation (and thematic roles)*: To what extent can the framework help bridge the gap between event-based and agent-based theories of causation.
- (c) *Spatiotemporal location of events*: To what extent might the framework aid in addressing first-order issues in the metaphysics of events, particularly concerning the individuation of their spatiotemporal boundaries.
- (d) *Persistence of objects*: To what extent can the framework be appropriated, so to speak, by heterodox theories of persistence in which objects are present in time (and persist) by participating in events.¹⁰

2 The Basic Theory

We shall be working within standard first-order logic with identity and definite descriptions. The non-logical vocabulary will comprise two primitive monadic predicates, *O* ('is an object') and *E* ('is an event'), and two primitive relational predicates, *P* ('is part of') and *PC* ('participates in'). Both relational predicates will initially be treated as binary, as we shall restrict our attention to their behavior without regard to temporal or modal qualifications, reading the verb timelessly and amodally. We shall consider the possibility of extending the framework to accommodate locutions of the form '*x* is part of *y* at *z*' and '*x* participates in *y* at *z*', where *z* is either a time or a world, in the final section.

2.1 Objects and Events

Since the precise distinction between objects and events is contentious, we shall remain silent about the admissible ways of interpreting the two monadic predicates, *O* and *E*, provided that both extend over actual spatiotemporal particulars. Our

⁸ As we said, here we are thinking of events as spatiotemporal particulars. This conception has become popular with Davidson [30, 33], but there are philosophers who conceive of events as universals, e.g. Montague [84] and Chisholm [16]. For such philosophers, the question would be especially pressing. Indeed, it may be pressing even for some particularists, such as Kim [67], for whom events *are* exemplifications of universals by objects.

⁹ The term itself, 'participation' (Greek: μέθεξις), was first used philosophically by Plato, though he refrained from specifying "the precise nature" of the relation (*Phaedo* 100d). For a history, see Annice [2]. For other uses of the concept in metaphysical and theological theorizing, not considered here, see Hampton [53] and the essays in Ferrer and Sherman [36].

¹⁰ Thanks to two anonymous referees for raising this issue.

initial assumptions concerning these predicates will therefore be minimal and will simply fix the basic existential and relational requisites. Specifically, we assume that O and E are both non-empty and mutually exclusive.

A1	$\exists xOx$	<i>Object Existence</i>
A2	$\exists xEx$	<i>Event Existence</i>
A3	$Ex \rightarrow \neg Ox$	<i>Exclusion</i>

(Unless otherwise specified, all formulas with free variables, such as A3, are to be understood as universally closed.) Clearly, A3 is incompatible with any view that outright rejects the categorial distinction between objects and events. In a more general setting, it could be dropped. However, here we are interested in regimenting event participation in the context of theories that do accept the distinction, and A3 is to be read in this spirit. On the other hand, though mutually exclusive, we do not assume the two categories to be jointly exhaustive of everything there is, as per the following principle:

P1	$Ox \vee Ex$	<i>Totality</i>
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P1 is equivalent to the converse of A3 and would therefore yield a biconditional, allowing each category to be defined as the complement of the other. Indeed, we shall see that both O and E could, under suitable assumptions about the relation of participation, be introduced by definition. Generally speaking, however, we want our basic framework to remain neutral on such matters, so for now we simply assume A1–A3 and treat both predicates as primitives.

2.2 Parthood

We assume the parthood relation expressed by P , which we take to include identity as a limiting case, to be independently understood. In particular, we shall suppose without argument that some objects can be part of other, larger objects (as a leaf is part of a tree) and that some events can be part of other, more complex events (as a step is part of a walk), though we shall leave it open whether an object can be part of an event or vice versa. The following auxiliary predicates and functors will also be employed:

D1	$PPxy := Pxy \wedge \neg x=y$	<i>Proper Parthood</i>
D2	$Dxy := \neg \exists z(Pzx \wedge Pzy)$	<i>Disjointness</i>
D3	$Ax := \neg \exists yPPyx$	<i>Atomhood</i>
D4	$F_{\varphi z}w := \forall z(\varphi z \rightarrow Pzw) \wedge \forall x(\forall z(\varphi z \rightarrow Pzx) \rightarrow Pwx)$	<i>Fusion</i>
D5	$fz\varphi z := \imath w F_{\varphi z}w$	<i>Unique Fusion</i>
D6	$x+y := fz(Pzx \vee Pzy)$	<i>Sum</i>
D7	$x-y := fz(Pzx \wedge Dzy)$	<i>Difference</i>

(In D4 and D5, φz is any formula in which the variable z occurs free and the formula ' $F_{\varphi z}w$ ' may be read as ' w is a fusion of every z such that φz ', or simply ' w is a fusion of the φ -ers' or ' w is composed of the φ -ers'.)

The formal properties of P depend on the mereological theory one adopts, and here there is, of course, room for a wide range of options. The strongest would be the theory known as classical mereology. This is the theory stemming from the work of Leśniewski [75] and Leonard and Goodman [74], which we shall consider in the form presented by Cotnoir and Varzi [28]. It is defined by the following axioms, the last of which is actually an infinitary schema yielding a distinct axiom for each open formula φz in the language.

A4	Pxx	<i>Reflexivity</i>
A5	$Pxy \wedge Pyx \rightarrow x = y$	<i>Antisymmetry</i>
A6	$Pxy \wedge Pyz \rightarrow Pxz$	<i>Transitivity</i>
A7	$\neg Pxy \rightarrow \exists z \forall w (Pwz \leftrightarrow Pwx \wedge Dwy)$	<i>Remainder</i>
A8	$\exists z \varphi z \rightarrow \exists w F_{\varphi z}w$	<i>Unrestricted Fusion</i>

These axioms establish that parthood structures are, essentially, Boolean partial orders without a bottom element but with a supremum (a unique fusion) for every specifiable non-empty collection of things. In other words, $fz\varphi z$ is defined if and only if φz is satisfiable. Accordingly, in classical mereology the sum $x + y$ is always guaranteed to exist, whereas the difference $x - y$ exists if and only if x is not part of y . The following abbreviations will also be helpful.

D8	$u := fzPzz$	<i>Universe</i>
D9	$\mathcal{O} := fzOz$	<i>Universal Object</i>
D10	$\mathcal{E} := fzEz$	<i>Universal Event</i>

Given A8, the existence of $\mathcal{U}$ in classical mereology follows from the Reflexivity axiom A4 while $\mathcal{O}$ and $\mathcal{E}$ exist in view of the Existence axioms A1 and A2. Moreover, since A4 is unrestricted, $\mathcal{U}$ must be composed of absolutely everything there is; it could also be defined as $fz \exists x z = x$. Similarly, $\mathcal{O}$ and $\mathcal{E}$ consist of *all* objects and *all* events, respectively. Such humongous and widely scattered fusions may not be among the entities countenanced by common sense (as with many other fusions warranted by A8), but their existence will prove relevant to the discussion of several interesting theses concerning participation.

Whether a fully classical mereology is the best option is, indeed, a matter of philosophical controversy, so we shall not officially assume the entire package consisting of A4–A8 (and, with it, the existence of the three fusions defined in D8–D10). Weaker mereological theories may be preferable for a variety of reasons.¹¹ Nonetheless, A4–A8 will provide a good set of axioms relative to which a wide range of theses can be examined. Similarly, it is a matter of controversy

¹¹ For an overview of the main options, and the underlying issues, see Cotnoir and Varzi [28], chs. 3–5.

whether the same mereological principles apply equally to objects and events. For instance, Simons [118] considers classical mereology to be an adequate theory in the domain of events but finds A7 and A8 too strong and implausible in regard to objects (especially if these are construed as enduring entities). We do not aim to resolve this issue here. Nonetheless, it is evident that much will depend on how one chooses to proceed on this front, too.

In addition to pure mereological axioms such as A4–A8, we shall assume the following axioms, to the effect that both objects and events are additive¹²:

$$\text{A9} \quad F_{\varphi z}x \wedge \forall z(\varphi z \rightarrow Oz) \rightarrow Ox \quad \textit{Object Additivity}$$

$$\text{A10} \quad F_{\varphi z}x \wedge \forall z(\varphi z \rightarrow Ez) \rightarrow Ex \quad \textit{Event Additivity}$$

Among other things, these axioms guarantee that $\mathcal{O}$ and $\mathcal{E}$ would indeed be an object and an event, respectively, justifying the terminology in D9 and D10. By contrast, as already mentioned, we do not require objecthood and eventhood to be disjunctive, i.e., we do not assume either of the following principles:

$$\text{P2} \quad Ox \wedge Pyx \rightarrow Oy \quad \textit{Object Dissectivity}$$

$$\text{P3} \quad Ex \wedge Pyx \rightarrow Ey \quad \textit{Event Dissectivity}$$

While principles such as these are occasionally endorsed in the context of formal participation theories involving objects and events,¹³ if not on broader philosophical grounds,¹⁴ neither is neutral enough for our purposes. For example, P2 would be incompatible with several well-regarded views about the nature of objects, such as Paul's [93] mereological bundle theory, according to which objects are fusions of properties, or Koslicki's [70] neo-Aristotelianism, according to which they are mereological compounds of matter and form. Similarly, P3 would conflict with certain popular views about the nature of events. On Kim's [67] theory, for instance, events are property exemplifications by objects at times, and this is sometimes construed as meaning that events are *constituted* by objects exemplifying properties at times (see [68]). If constitution is in turn construed as mereological composition, then objects would be part of the events in which they participate, contrary to P3. Finally, note that in classical mereology the conjunction of P2 and P3 would be incompatible with the Totality principle P1: the sum of an object and an event—whose existence would follow from A1 and A2 by the Unrestricted Fusion axiom A8—would have to be either an object or an event (and not both, by A3), yet its parts would come from both categories.

¹² This is a common move in the literature. Philosophically, it may be traced back to Cartwright [13], pp. 161f, and Thomson [130], pp. 78f, respectively, though A10 has occasionally been disputed (see e.g. [57], §4, and [1], p. 27).

¹³ See e.g. Masolo et al. [81] for a theory that assumes both P3 and (a variant of) P2.

¹⁴ See e.g. Quinton [99] and Hacker [52]. Johnson himself, in his classic treatment of the continuant/occurrent distinction, endorsed both forms of dissectivity ([62], pp. xxi, 92).

2.3 Participation

Concerning the participation relation, which is the main novelty, we shall proceed in two steps. We begin here with the pure axioms for *PC*, which govern the participation relation as such. We shall then devote the next two sections to examining a number of further principles that may be added to the pure theory to regiment the interaction between *P* and *PC* or to impose specific existence conditions on the interaction between *O* and *E*. The pure axioms are as follows.

A11	$PCxy \rightarrow Ey$	<i>Participation</i>
A12	$PCxy \rightarrow \neg PCyx$	<i>Asymmetry</i>
A13	$PCxy \wedge PCyz \rightarrow PCxz$	<i>Transitivity</i>

Axiom A11 forces the second argument of *PC* to be an event. This is the obvious way of capturing the thought that events are the sort of things in which one or more entities may participate in the sense here under consideration. However, we do not require that these other entities—the participants—must be objects or, more generally, non-events,¹⁵ i.e., we do not assume either of the following principles:

P4	$PCxy \rightarrow Ox$	<i>Object Participation</i>
P5	$PCxy \rightarrow \neg Ex$	<i>Non-Event Participation</i>

While we are especially interested in participation as a relational link between the two categories of objects and events, the link need not be exclusive. In particular, dispensing with these assumptions allows for the possibility of second-order events, i.e., events that have (other) events as participants—what Peterson [95] calls “complex events”.¹⁶ Consider, for example, Alf’s refusal of the job offer, Beth’s listening to the concert, or Gemma’s denunciation of the scandal: in each of these cases, the agent of the event is an object (a person) but the patient is a further event (a job offer, a concert, and a scandal, respectively). For another illustration, suppose a sphere is spinning, and suppose the spinning is gradually slowing down. One might describe this situation by saying that it is the sphere—and only the sphere—that is slowing down, thereby participating in two concurrent events, a spinning and a slowing down. Alternatively, one might describe the situation by saying that there is only one event, a spinning, which enjoys different properties at different times, initially it is fast, then it is slow. But one may also offer the following account: there is a spinning and there is a slowing down, and while the former is an ordinary event, with the sphere as its participant, the latter is a second-order event whose participant is the spinning itself: the spinning undergoes the slowdown. For a last example, consider causation.

¹⁵ Contrary to the formal theories mentioned above, all of which include such stipulations.

¹⁶ Similar considerations would apply to the relation of participating in a universal. Insofar as Socrates (a particular) is wise, he participates in wisdom (a universal). But wisdom itself may be said to participate in other universals, for instance, in the second-order property of being a virtue. The determinate/determinable relationship may also be seen in this light; see Wilson [139].

Pace Davidson [34], one might treat every causal transaction as an event, viz. a relational event whose main participants are the cause and the effect. Insofar as causes and effects are themselves events, as in most theories of causation, this would mean that causal transactions are second-order events—causings.¹⁷ All of this speaks against P4 and, more generally, against P5.

The next two axioms, A12 and A13, assert that *PC* is asymmetric and transitive, from which it follows immediately that it is also irreflexive:

$$T1 \quad \neg PCxx \quad \text{Irreflexivity}$$

Thus *PC* is a strict order. To be sure, the Asymmetry axiom A12 is somewhat redundant, since every instance in which *x* is not an event follows directly from the Participation axiom A11. The following weaker axiom would suffice:

$$A12' \quad PCxy \wedge Ex \rightarrow \neg PCyx \quad \text{Higher-Order Asymmetry}$$

However, we prefer our axioms to work independently and so we adopt A12 in its full strength. Moreover, it is worth noting that both A12 and the Transitivity axiom A13 would be fully derivable as theorems if either P4 or P5 were assumed as an axiom along with A11 (in the former case, owing to the fact that no object is an event by A3). In particular, Transitivity would hold vacuously, since the antecedent of the conditional would be contradictory.¹⁸ Absent P4 and P5, the two strict-order axioms must be assumed explicitly. But what this means, really, is that A12 and A13 are truly informative only with regard to participation in higher-order events.

Does (Higher-Order) Asymmetry capture an essential feature of participation? We hesitate to say so. Just as the Antisymmetry axiom for *P*, A5, has sometimes been challenged, leading to the development of “non-wellfounded” mereologies that tolerate cases of mutual parthood,¹⁹ one may similarly wish to allow for the possibility of participation loops where two or more events participate in each other. For example, it has been argued that a statue and the corresponding amount of matter, though distinct, are each part of the other (Thomson [131]).²⁰ Analogously, it might be suggested that the life of a statue participates in the life of the matter, and vice versa.²¹ There is, really, nothing in the meanings of ‘part’ and ‘participation’ that rules out such scenarios a priori. With regard to participation in universals, for instance, Plato’s theory of forms explicitly contravenes

¹⁷ Besides Peterson [95], the view that causings are themselves events is not uncommon also among philosophers who endorse theories of agent causation. See e.g. Chisholm [17], p. 40, Zimmerman [141], p. 590, and O’Connor [89], p. 49ff, for explicit statements.

¹⁸ *Contra* Keet and Artale [66], p. 99 and Arp et al. [4], p. 148, among others.

¹⁹ See Cotnoir and Bacon [27].

²⁰ For more examples, see Cotnoir and Varzi [28], §3.2.

²¹ Note that this sort of mutual participation would have nothing to do with the homonymous phenomenon discussed in the literature on reciprocal verbs, like ‘meet’ or ‘kiss’ (see e.g. the essays in König and Gast [69]). From the present perspective, such verbs refer to perfectly ordinary (first-order) events in which two or more participants share equal, symmetric roles.

A12, even T1.²² Still, it seems to us that when it comes to events, the possibility of participation loops is best understood as a deviation from the rule, and the rule should take precedence. Assuming that *P* satisfies the Antisymmetry axiom A5 will allow us to set aside all kinds of “strange” parthood structures—as Cotnoir [26] calls them—that would only be distracting for our present purposes. We shall likewise defer the treatment of “strange” participation structures violating A12—all of which would involve higher-order events—to future work.²³ There is enough to be learned by exploring the *terra firma* of a well-founded mereology and participation theory.

What about the Transitivity axiom A13—does it capture a plausible feature of participation? Here, too, there is room for debate. Consider again the spinning sphere. The sphere participates in the spinning, and the spinning, we said, may be construed as participating in a second-order event of slowing down. One way to preserve the alternative intuition—that the sphere itself is slowing down—is to say that it slows down insofar as it participates in an event that participates in the slowing down. This is precisely the inference warranted by Transitivity. (The relation of participation in Plato’s hierarchy of forms may also be seen as transitive in this sense: insofar as Socrates participates in wisdom, and wisdom participates in the second-order universal of being a virtue, Socrates himself would be virtuous.²⁴) Other cases, however, are more dubious. Suppose the job offer that Alf refused came from Beth. Beth participated (as an agent) in the offer, and the offer, in turn, participates (as a patient) in the higher-order event of Alf’s refusal. Does it follow that Beth participated in the refusal? One might be inclined to say no: the participants in the refusal do not seem to extend beyond Alf and the job offer. Still, there is a clear sense in which Beth was involved in (and affected by) that event. It is *her* offer that Alf refused, not someone else’s, and precisely for this reason Beth may be disappointed. One might explain the disappointment in terms of causation: Alf’s refusal *caused* Beth’s disappointment. But one might as well explain it in view of the fact that Beth (as opposed to the party whose offer Alf accepted) was somehow involved in the refusal.²⁵ Arguably, the choice has implications for the long-standing debate over the spatiotemporal individuation of events. For example, consider the view that an event’s location is determined by the locations of its participants [32, 79]. On this view, the spatiotemporal profile of Alf’s refusal would depend crucially on whether one takes Beth to be a participant in the refusal, as Transitivity dictates.

²² Whence the “third man” argument. See e.g. Vlastos [134] and Schweizer [114].

²³ One might wish to consider *PC* Antisymmetry as an alternative option to the axiom of *PC* Asymmetry. That change would allow for cases of (higher-order) reflexive participation, though it is difficult to come up with paradigmatic illustrations. This points to a significant difference with respect to the relation of participation in universals, where the possibility—if not the necessity—of *bona fide* self-participating universals has been seriously entertained since Plato’s theory of forms. See e.g. Nehamas [86].

²⁴ This is actually controversial; see e.g. Moravcsik [85] vs. Cohen [22] for a classic exchange. Similar considerations apply to Aristotle’s hierarchy, especially in view of his explicit commitment to the transitivity of ‘being said of’ in *Categories* 3, 1b10–15; see e.g. Rohr [104] and the discussion of Principle FP2 in Code [21].

²⁵ ‘Involved’ is admittedly generic. On a more fine-grained account, one may want to distinguish between immediate participation (here: Alf’s participating in the refusal) and mediate participation (Beth’s).

For another illustration, Brutus participated in the stabbing of Caesar, which caused Caesar's death. On a plausible analysis, as we saw, causal transactions may be viewed as second-order events. In particular, causing someone's death may be seen as the second-order event of killing them.²⁶ Such an event would include both the cause (here: Brutus' stabbing) and the effect (Caesar's death) as participants. But it seems plausible to say that it also includes the killer (here: Brutus) and the victim (Caesar). Thus, the participants in the stabbing, which participates in the killing, would also participate in the killing, albeit in different thematic roles. While Brutus participated in the stabbing as an agent, he may be said to have participated in the killing, not as an agent (a role now occupied by the cause, i.e., the stabbing itself), but as a *causal source*. And while Caesar participated in the stabbing as a patient, he may be said to have participated in his own killing, not as a patient (which should be identified with the effect of the stabbing, i.e., Caesar's death), but as a *causal target*.²⁷

These are just examples, and by no means suffice to establish that the participation relation is transitive. Nonetheless they are indicative of the intended import of the Transitivity axiom A13. Not much in what follows, however, will depend on this axiom, especially insofar as A13 applies non-vacuously only when the variable z picks out a higher-order event.

Let us also stress that our examples, here and below, are intended merely as aids to intuition. We left the interpretation of the predicates O and E open precisely because our goal is to formalize a notion of participation whose central features are not tied to particular views about the nature of objects and events, but of course a purely abstract, formal treatment would be hard to assess. In particular, it will be clear that we take all our examples to illustrate one and the same general notion of participation. With parthood, as already noted, it is an open question whether a single relation can fit every use of 'part of'; some authors would rather posit different primitive relations for different kinds of entity,²⁸ or even different relations among entities of the same kind.²⁹ With participation we have the same options. Here we are assuming that a single participation relation underlies all cases. For example, we follow the linguistic literature on thematic roles in treating both agents and patients as equally legitimate

²⁶ In line with the classical analysis of 'kill' [73, 82]. The analysis has been contested [41, 138], but the objections are not relevant here.

²⁷ In this sense, the transitivity of PC parallels the transitivity of P (A6) *vis-à-vis* putative counterexamples involving the hierarchical use of 'part'. A typical illustration, from Rescher [100], would be the biological subunits of a cell, such as the nucleus, which are not said to be part of the organ of which that cell is part. As Simons [118], p. 108 notes, this really means that the nucleus is not a functional part of the organ, although it is a functional part of the cell and the cell a functional part of the organ. So *functional parthood* is not transitive; yet that is no counterexample to the transitivity of parthood *simpliciter*. (For more on this, see [133] vs. [59].) Similarly, here Brutus would not be an agent in the killing of Caesar, though he would be an agent in the stabbing which is the agent of the killing. This means *agent participation* may not be transitive, but has no bearing on the transitivity of participation *simpliciter*. The case of *immediate participation* (note 25) would be analogous.

²⁸ See e.g. McDaniell [83], Johansson [60], and Wallace [136] for recent proposals.

²⁹ As in Fine [39].

participants, even though there is a clear sense in which an agent participates more “actively” than a patient. One might instead adopt a pluralist framework, treating e.g. active and passive participation as genuinely distinct relations, or distinguishing between the ways in which something may participate in a process (walking uphill), an accomplishment (climbing the mountain), an achievement (reaching the top), etc. Such a pluralist account is certainly worth considering. However, here we shall not pursue it.

We conclude this section by introducing two auxiliary notions that will prove useful in stating some of our later results.³⁰

D11	$\rho x \equiv fzPCxz$	<i>Record</i>
D12	$\tau y \equiv fzPCzy$	<i>Theme</i>

Intuitively, the record of something is the fusion of all events in which it participates, whereas the theme of an event is the fusion of all its participants. In the presence of the Fusion axiom, A8, both notions may be undefined for some arguments, but are sure to be uniquely defined whenever x participates in some event and whenever y has some participant, respectively (two conditions we shall examine in Sect. 4). Thus, given A8, the following conditionals will always hold:

T2	$PCxy \rightarrow Py(\rho x)$	<i>Record Inclusion</i>
T3	$PCxy \rightarrow Px(\tau y)$	<i>Theme Inclusion</i>

Moreover, given the Participation axiom A11, the variable z in D11 must range over events, so the Event Additivity axiom A10 will guarantee that a participant’s record is always an event. The ontological status of an event’s theme, however, may vary. In particular, since we are not assuming Object Participation (P4), the Object Additivity axiom A9 does not suffice to guarantee that an event’s theme—when it exists—must be an object.

3 Developments, I – Bridging Principles

The basic theory outlined above can be extended in various ways. We begin in this section by examining several bridging principles connecting parthood and participation. In the next section we shall consider a number of additional existential principles.

³⁰ Both notions may be found in Masolo et al. [81], though records are called ‘lives’ and themes ‘maximal participants’. We resist the latter label because, generally speaking, there is no guarantee that an event’s theme is itself a participant in the event (see below, P31). As for ‘life’, it is a nice term, but it implies, e.g., that someone’s death is part of their life, which is philosophically contentious. (A good alternative would be ‘history’, following Perry [94], p. 467, were it not that this term is used in formal participation theories with other meanings.)

3.1 Reductive Conditions

The simplest bridging principles that come to mind are sweeping inclusion principles reducing one relation to the other. There are four logically distinct options in this regard, and it is worth going through each of them in turn.

P6	$Pxy \rightarrow PCxy$	<i>Parthood Inclusion</i>
P7	$Pxy \rightarrow PCyx$	<i>Inverse Parthood Inclusion</i>
P8	$PCxy \rightarrow Pxy$	<i>Participation Inclusion</i>
P9	$PCxy \rightarrow Pyx$	<i>Inverse Participation Inclusion</i>

The first of these principles asserts that parthood is a kind of participation. This is actually incompatible with the basic theory outlined above, since P is reflexive (by A4) whereas PC is irreflexive (by T1). One may consider substituting P with PP , which is irreflexive (by D1), but even this weaker variant of P6 is ruled out, at least so long as there are non-atomic objects: any such would violate the Participation axiom A11 or else the Exclusion axiom A3. There may perhaps be a sense in which proper parts may be said to participate in the larger entities that comprise them,³¹ but it isn't the sense of 'participate' that PC is meant to capture. At best we can restrict P6 to the proper parts of events:

P10	$PPxy \wedge Ey \rightarrow PCxy$	<i>Parthood Inclusion for Events</i>
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This would be formally acceptable, though at the cost of obliterating the distinction between complex and composite events altogether: every event composed of smaller events would *ipso facto* qualify as second-order.

Similar considerations apply to P7, which asserts that parthood is a kind of inverse participation. Given the reflexivity of P , this reductive principle is incompatible with the irreflexivity of PC while its variant in terms of PP is incompatible with the Exclusion and Participation axioms, at least insofar as objects can be parts of other entities.³² If there is a sense in which an entity may be said to participate in its proper parts, it isn't the sense corresponding to the relation PC . Nonetheless, the restriction of P7 to eventive proper parts would be formally acceptable³³:

P11	$PPxy \wedge Ex \rightarrow PCyx$	<i>Inverse Parthood Inclusion for Events</i>
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The third and fourth principles, P8 and P9, are reductive in the opposite direction, and somewhat more interesting. P8 reduces participation to a kind of parthood relation, i.e.,

³¹ Cf. Heidegger: "The part shares itself with parts in a whole. It takes part in the whole [*nimmt am Ganzen teil*]" ([56], p. 36/34).

³² Actually, this condition is always satisfied, since the Existence and Exclusion axioms A1–A3 entail that every object is a proper part of the universe, $\mathcal{U}$.

³³ In this case, at the cost of automatically treating every non-universal event as complex, owing to the participation of $\mathcal{E}$.

effectively, a kind of proper parthood (since PC is asymmetric), whereas P9 reduces it to a kind of inverse proper parthood.³⁴ Formally, both reductions are compatible with the basic framework of Sect. 2. We explicitly assumed that objects and events form disjoint categories (by A3), so no object can be identical with an event, but that doesn't preclude the possibility that objects and events be mereologically related via proper parthood. As mentioned in connection with the Dissectivity principle P3, Kim's [67, 68] popular theory can in fact be construed as holding that objects are constitutive parts of the events in which they participate, in line with P8, and the same could be said of Peterson's [95] extension to higher-order events (treating events as constitutive of any events in which they participate).³⁵ Moreover, in the presence of the partial-order axioms of classical mereology (A4–A6), PP is asymmetric as well as transitive, hence a strict order, much like PC . It is therefore a substantive question what, if anything, distinguishes the two relations, besides the fact that the latter requires the second relatum to be an event. Similarly for PC versus the inverse of PP , which is also a strict order, although it is more difficult to think of actual philosophical theories endorsing P9.³⁶

We shall not address the metaphysical aspect of this question here. We are interested primarily in the tenability of the reductions afforded by P8 and P9, were one to endorse either principle on top of the basic theory. (Endorsing both is not an option, given the antisymmetry of P and the irreflexivity of PC .) And in this regard, the first point to notice is that P8 and P9 are not on equal footing; the latter principle is uncomfortably stronger. For example, by reducing PC to the inverse of PP , P9 automatically makes all participants non-atomic:

$$\text{P12} \quad PCxy \rightarrow \neg Ax \qquad \text{Participant Compositeness}$$

Another immediate consequence of P9 is that co-participation entails mereological overlap, i.e., non-disjointness:

$$\text{P13} \quad PCxy \wedge PCzy \rightarrow \neg Dxz \qquad \text{Participant Overlap}$$

³⁴ Both views have actual counterparts for the participation relation with regard to universals: P9 would deliver a mereological bundle theory *à la* Paul [93] and P8 a version of the medieval theory of collective realism, according to which universals are integral wholes composed of the particulars that instantiate them (see Freddoso [42]). One important difference, however, is that such theories do not only reduce one relation to (the inverse of) the other; they also reduce one ontological category to the other: an object *just is* a fusion of universals and a universal *just is* a fusion of objects, respectively. Thus, they would reject either the Additivity axioms A9 and A10 or the Exclusion axiom A3 (with 'universal' in place of 'event').

³⁵ Other event theories in line with P8 include Sowa [112], ch. 2, and Keet [65]. See also Schneider [112] for an account that explicitly endorses P8. As noted in the Introduction, the views of perdurantists such as Goodman, Broad, or Quine could also be seen as entailing P8, except that, again, those views are ontologically reductionist, hence incompatible with A3.

³⁶ One may perhaps think of Sartre: "Man is ... nothing else but the sum of his actions" ([109], p. 55/41). This use of 'sum', however, is hardly to be taken in strict mereological terms. And even if it were (as in Wiseman [140], pp. 80f: "My actions are part of me ... I am the sum of my actions"), it would only yield P9 in the limited case where x is a person and y an action. Moreover, it would be compatible with A9 only if persons were themselves events (say, their own lives), thus collapsing into a version of perdurantism whenever applicable.

These consequences are not intrinsically objectionable, but they do call for extensive mereological revisionism.³⁷ Further awkward consequences arise when broader issues are taken into account. For instance, P9 is at odds with the standard view that the spatiotemporal location of a composite entity encompasses the locations of its proper parts³⁸: short of accepting that, say, a war soldier is located wherever and whenever the war takes place, one would have to deny that the soldier is truly a participant in the whole war (as opposed to a few restricted episodes). No such concerns arise with P8. By reducing *PC* to *PP*, this principle implies the event counterparts of both P12 and P13:

$$\begin{array}{ll} \text{P14} & PCxy \rightarrow \neg Ay \\ \text{P15} & PCxy \wedge PCxz \rightarrow \neg Dyx \end{array} \quad \begin{array}{l} \text{Event Compositeness} \\ \text{Event Overlap} \end{array}$$

Yet these implications are hardly disturbing. Indeed, both are precisely what one would expect on a conception of events as structured entities, as with the mereological version of Kim's theory. Similarly for the broader implications of P8 with regard e.g. to the theory of location. Whenever the event is larger than the participant, as in the war/soldier case, P8 poses no difficulty. If anything, concerns may arise when the event's location appears narrower—say, a person experiencing a headache—but in such cases it wouldn't seem so bad to restrict the relevant participants accordingly (e.g., to the person's head).

There is, however, one further feature of P8 and P9 worth noting. If one assumes the Remainder axiom for *P*, A7 (along with the Asymmetry axiom for *PC*, A12), these principles imply, respectively, that subtracting a participant from an event or an event from a participant always leaves something. Indeed, there would always be a remainder even if we subtracted all participants or all events, respectively, so long as the given event is not included in its own theme and the given participant in its own record (as is ordinarily the case)³⁹:

$$\begin{array}{ll} \text{P16} & PCxy \wedge \neg Py(\tau y) \rightarrow \exists z z = y - \tau y \\ \text{P17} & PCxy \wedge \neg Px(\rho x) \rightarrow \exists z z = x - \rho x \end{array} \quad \begin{array}{l} \text{Right Remainder} \\ \text{Left Remainder} \end{array}$$

Intuitively, this means that the reductions afforded by P8 and P9 impose a “splitting” of every ordinary participated event and every ordinary event participant,

³⁷ For example, one could introduce a stronger notion of overlap, defined in terms of a common object part, and similarly for a stronger notion of atomicity. This would be comparable to the stronger notions that are needed in the context of a mereology with a null individual that is part of everything. (See [28], §4.5.) Cf. also Paul's [93] mereological bundle theory, where something can be materially atomic while still having logical parts.

³⁸ For details, see e.g. Gilmore et al. [45].

³⁹ Technically, insofar as higher-order events are allowed, the basic theory does not prevent an event *y* from being composed entirely of events and having all of them as participants (in which case the mereological fact that $y = fxPPxy$ would yield $Py(\tau y)$) or a participant *x* from being likewise composed of events and participating in each of them (resulting in $Px(\rho x)$). Unless P11 and P12 are also endorsed, however, it is hard to imagine cases of these kinds.

respectively, into two disjoint halves. In each case, one half—the subtrahend—is clear enough. The challenge, for anyone endorsing P8 or P9, is to clarify the exact nature of the other half—the remainder.

3.2 Restrictive Conditions

Opposite to the inclusion conditions expressed by P6–P9, we may consider conditions asserting the relative exclusion of parthood and participation.

P18	$PCxy \rightarrow \neg Pxy$	<i>Mereological Exclusion</i>
P19	$PCxy \rightarrow \neg Pyx$	<i>Inverse Mereological Exclusion</i>

These principles (or their contrapositives) do not express reductive analyses. Rather, they restrict drastically the interaction between the two relations.

According to P18, the two relations are completely disjoint: no participant is ever part of an event in which it participates, and so, by contraposition, no part can ever participate in the larger wholes to which it belongs. These claims are the exact contraries of Participation Inclusion, P8, and of Parthood Inclusion, P6, respectively. Thus, P18 is openly incompatible with any theory endorsing the reductive analyses afforded by those principles,⁴⁰ at least so long as PC is non-empty. On the other hand, it is easy to see that, given the basic axioms, P18 would be derivable from the Inverse Participation Inclusion principle P9, since $PCxy$ together with Pyx implies $PPyx$ (by the asymmetry of PC) and, hence, $\neg Pxy$ (by D1 and the antisymmetry of P). P18 would also follow as a theorem if one assumed the Non-Event Participation principle P5 along with the Event Dissectivity principle P3. Absent any such principles, however, P18 expresses an independent constraint on PC and must be assessed on its own grounds. Among other things, it implies that nothing can participate in the universe (in case $\mathcal{U}$ qualified as an event) and that no event can participate in the universal event. Moreover, given the reflexivity of P , the assumption of P18 would imply that PC is irreflexive and hence, given the Transitivity axiom A13, asymmetric. Axiom A12 would thus become redundant.⁴¹

As for P19, this principle asserts that nothing participates in any of its parts. It is therefore incompatible with the reductive analyses expressed by Inverse Participation Inclusion, P9, and by Inverse Parthood Inclusion, P7,⁴² though it would actually follow from the Participation Inclusion principle P8. Additionally, like P18, P19 would follow as a theorem in the presence of other principles we already discussed, such as Object Participation, P4, plus Object Dissectivity, P2, and would be strong enough to render A12 redundant. It would also, however, rule out certain possibilities that might seem independently plausible. For instance, it would follow from P19 that neither the universe nor the universal event can participate in any event.⁴³

⁴⁰ Or by the weaker variant of P6 corresponding to P11, since P6 is already in conflict with the basic axioms of Sect. 2.

⁴¹ All these implications should therefore be added to the consequences of P9 noted above.

⁴² Or by its weaker variant P12, since P7 is already in conflict with the basic axioms.

⁴³ Again, these implications should be added to the consequences of P8 noted above.

3.3 Monotonicity

There are other, subtler ways in which parthood and participation may be thought to interact besides the reductive and restrictive conditions corresponding to P6–P9 and P18–P19. Chief among these, we may consider various ways in which the participation relation may be sensitive to the mereological structure of its relata, corresponding to the following forms of monotonicity.⁴⁴

P20	$PCxy \wedge Pyz \wedge Ez \rightarrow PCxz$	<i>Right Upward Monotonicity</i>
P21	$PCxy \wedge Pxz \rightarrow PCzy$	<i>Left Upward Monotonicity</i>
P22	$PCxy \wedge Pzx \rightarrow PCzy$	<i>Left Downward Monotonicity</i>
P23	$PCxy \wedge Pzy \wedge Ez \rightarrow PCxz$	<i>Right Downward Monotonicity</i>

(In P20 and P23, the third conjunct in the antecedent is dictated by the Participation axiom A11, which requires the second relatum of PC to be an event.)

The first of these principles, P20, asserts that whatever participates in part of an event participates in the entire event. This is arguably the most plausible principle in the list and aligns well with much ordinary and philosophical talk. For instance, it is natural to say that whoever participated in the Somme Offensive participated in World War I (one reason why the Inverse Inclusion principle P9 was found problematic), and if you are watching Cordelia say “Nothing, my Lord”, you are thereby attending a performance of *King Lear*. There is perhaps room for concern about the extent of the relevant event part: did you really attend *King Lear* if you only witnessed Cordelia’s utterance? This worry, however, reflects the vagueness of the binary notion of participation we are working with, which is insensitive to temporal qualifications, so we may set it aside for now. (We return to this issue in Sect. 5.1.) By contrast, let us stress that P20 does not require the participant, x , to be an object and, indeed, similar remarks apply to higher-order events. If Gemma’s denunciation of the scandal was part of a broader political crusade, it’s plausible to say that the scandal itself played a role in the crusade. Moreover P20 has sensible consequences in classical mereology. For example, it entails that PC is closed under summation on the event side: whatever participates in two events participates in their sum.

P24	$PCxy \wedge PCxz \rightarrow PCx(y+z)$	<i>Finite Right Additivity</i>
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This follows from P20 in view of the fact that $Py(y+z)$ is a theorem of classical mereology (as is $Pz(y+z)$), and any sum of events is guaranteed to be an event by the Event Additivity axiom A10. The infinitary extension of P24 would also be derivable:

P25	$\exists z \varphi z \wedge \forall z (\varphi z \rightarrow PCxz) \rightarrow PCx(fz \varphi z)$	<i>Right Additivity</i>
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⁴⁴ P20 may be found in Simon [117], while Borgo and Masolo [8] assume (a time-indexed version of) both P20 and P22. See also Borgo and Mizoguchi [9]. Principles of this sort are also discussed in some linguistic literature, beginning with Krifka [71, 72].

Hence, in particular, every participant would participate in its own record:

$$\text{P26} \quad PCxy \rightarrow PCx(px) \quad \text{Record Participation}$$

On the other hand, another obvious corollary of P20 is that whatever that participates in some event or other participates in the universal event:

$$\text{P27} \quad PCxy \rightarrow PCx\varepsilon \quad \text{Upward } \varepsilon\text{-Involvement}$$

This is somewhat unpleasant, since it implies that all such entities—all participants—have the same record, trivializing the concept (and, with it, P26):

$$\text{P28} \quad PCxy \rightarrow px = \varepsilon \quad \text{Record Sameness}$$

As we noted, P20 is the most plausible principle in the list of various forms of monotonicity. Interestingly, it might be used to tease out a significant difference between event participation and the relation of participation with regard to universals. On the face of it, the latter offers counterexamples to P20, or rather, to its analogue for universals. Roughly, this analogue would state that if an object participates in a universal u , then it participates in every universal of which u is part. Suppose x is a red sphere. Then x participates in the universal *being spherical*. Now consider the conjunctive universal *being spherical and yellow*. On the assumption that *being spherical* is part of this conjunctive universal, and that participating in a conjunctive universal requires participating in each conjunct, x does not participate in *being spherical and yellow* because it does not participate in *being yellow*, thus violating the universal-relative analogue of P20. Of course, this counterexample relies on the acceptance of conjunctive universals, which is itself contentious. More generally, it presupposes the existence of mereologically structured universals, and this, too, has been questioned at least since Lewis [77]. Even so, the contrast with event participation is noteworthy.

Next comes Left Upward Monotonicity principle, P21. It asserts that whenever something, x , participates in an event, so does anything of which x is part. This principle is somewhat symmetric to P20, and indeed its main consequences in classical mereology are perfectly parallel to P24–P28:

$$\begin{aligned} \text{P29} \quad PCxz \wedge PCyz &\rightarrow PC(x+y)z && \text{Finite Left Additivity} \\ \text{P30} \quad \exists z\varphi z \wedge \forall z(\varphi z \rightarrow PCzy) &\rightarrow PC(fz\varphi z)y && \text{Left Additivity} \\ \text{P31} \quad PCxy &\rightarrow PC(\tau y)y && \text{Theme Participation} \\ \text{P32} \quad PCxy &\rightarrow PCuy && \text{Upward } u\text{-Participation} \\ \text{P33} \quad PCxy &\rightarrow \tau y = u && \text{Theme Sameness} \end{aligned}$$

However, the overall intuitive appeal this principle seems less robust, especially in the presence of the Unrestricted Fusion axiom A8. Socrates participates in the dialogue with Crito; but would we say the same of the mereological sum of Socrates and Diotima, or of

Socrates and the moon?⁴⁵ Would we count among the participants of the Somme Offensive the fusion of all soldiers of World War I? P21 says we should, but such verdicts are debatable. (The headache example mentioned in connection with the Inclusion principle P8 might be another case in point.) On the other hand, the special cases covered by P29 seem tenable. Since Crito is no less a participant in the dialogue than Socrates, *their* sum may plausibly be said to participate as well. Similarly for the participants in the Somme Offensive. Refraining from the full strength of P21, it might therefore be reasonable to endorse at least P29, if not its infinitary extension P30. It should still be noted, however, that a sum or fusion of participants need not be ontologically homogeneous. P29 and P30 appear most plausible when this condition is met, i.e., when all the participants are objects or all are events. When the participants come from both categories, as with Alf's refusal of the job offer, intuition wavers. We shall return to such cases in Sect. 4.3. Finally, note that P29 points to another difference between event participation and participation in universals. Consider two spheres, x and y . Both participate in the universal *being spherical*, yet their mereological sum $x + y$ does not. Thus, even Finite Left Additivity would fail for universal participation.

Consider now Left Downward Monotonicity, P22. This principle states that whenever something participates in an event, so do its parts. This is *prima facie* plausible. For instance, it seems fair to say that the Somme Offensive includes, among its participants, not only a certain number of soldiers, but also their proper parts. However, on closer inspection, even P22 appears vulnerable to counterexamples. While Socrates participates in the dialogue with Crito, his liver does not.⁴⁶ A spinning sphere participates in the spinning, but its center does not. The Texas Western Miners won the epic 1966 NCAA final, and David Palacio was part of the Miners; but since Palacio did not play that night, he did not participate in the event.⁴⁷ Indeed, P22 implies that everything participates in every event whose participants include the universe,

$$P34 \quad PCuy \rightarrow PCxy$$

Downward u-Participation

and this, too, is questionable. Presumably, there are things the universe is doing to which we contribute nothing at all—e.g., expanding, cooling off, etc.

It might seem that Left Downward and Left Upward Monotonicity should stand or fall together. Any misgivings about Socrates' liver being a participant in his dialogue with Crito turns into misgivings about the sum of Socrates and Diotima being a participant, and vice versa. However, the conjunction of P21 and P22 is actually untenable. Suppose we accepted P21, so that the sum of Socrates and Diotima would count as a participant in Socrates' dialogue with Crito. Then P22 would imply that Diotima herself participates in the dialogue, and this is preposterous. Indeed, things would be even

⁴⁵ Assuming such sums exist, as guaranteed by the Unrestricted Fusion axiom A8. Some authors part company with classical mereology precisely in this respect; see Markosian [80].

⁴⁶ Some authors take this sort of case as a counterexample to the transitivity of parthood, A6; see e.g. Johnston [63], p. 143. That is incorrect unless parthood includes participation, as per P8. And even so, the counterexample would remain susceptible to the response mentioned in note 27 unless one also assumes the converse inclusion, P6, which is at odds with the basic theory regardless of A6.

⁴⁷ This last example depends on treating group-membership as a genuine case of parthood. That is contentious, but see e.g. Hawley [54] for a recent defense.

worse. By P32 (a consequence of P21), the universe would participate in every participated event. Hence, by P22 and D8, everything would participate in every such event:

$$P35 \quad PCxy \rightarrow PCzy \quad \text{Spreading}$$

whence it follows that everything would participate in the very same events:

$$P36 \quad PCxy \leftrightarrow PCzy \quad \text{Sameness}$$

This would trivialize the notion of participation altogether.

Finally, consider the Right Downward Monotonicity principle, P23. It says that any participant of an event participates in all its subevents. Thus, in particular, whatever participates in the universal event participates in every event.

$$P37 \quad PCx\epsilon \rightarrow PCxy \quad \text{Downward } \epsilon\text{-Involvement}$$

Here we can be brief, since this principle is plainly false. Surely many soldiers participated in World War I without participating in the Somme Offensive. Surely Cicero did not participate in the stabbing of Caesar, despite participating in the broader rebellion of which the conspiracy to kill Caesar was part. And surely lots of things participate in the sum of all that happens, ϵ , without participating in a great many smaller events that make up that sum.

3.4 Modes of Participation

The preceding discussion, particularly regarding the monotonicity principles P20–P23, indicates that parthood and participation do not interact as robustly as one might hope. However, it also points to the fact that participation, as expressed by the predicate PC , is somewhat insensitive to the mereological structure of its relata. After all, there is a sense in which the sum of Socrates and Diotima *may* be said to participate in the dialogue, namely, by having a part that participates in it—the Socrates part if not the Diotima part. Similarly, if there is a sense in which Socrates himself participates in the dialogue with Crito, despite his liver playing no role, it is because some other parts of Socrates are directly involved in the event—say, his head and gesticulating arms.

This suggests that participation is not an all-or-nothing affair; something can participate in an event in different ways and to various extents. To capture this intuition, it may therefore be helpful to introduce a number of explicit distinctions. Consider the following.

$$\begin{array}{ll} D13 & NPCxy \equiv Ey \wedge \exists z(Pzy \wedge PCxz) & \text{Narrow Participation} \\ D14 & PPCxy \equiv \exists z(Pzx \wedge PCzy) & \text{Partial Participation} \\ D15 & IPCxy \equiv \exists z(Pxz \wedge PCzy) & \text{Indirect Participation} \\ D16 & OPCxy \equiv Ey \wedge \exists z(Pyx \wedge PCxz) & \text{Oblique Participation} \end{array}$$

Given the reflexivity of parthood, A4, it's clear that *PC* implies each of these four relations. The converse implications, however, need not hold, and correspond precisely to the four monotonicity principles discussed above:

P20*	$NPCxy \rightarrow PCxy$	<i>Right Upward Monotonicity</i>
P21*	$PPCxy \rightarrow PCxy$	<i>Left Upward Monotonicity</i>
P22*	$IPCxy \rightarrow PCxy$	<i>Left Downward Monotonicity</i>
P23*	$OPCxy \rightarrow PCxy$	<i>Right Downward Monotonicity</i>

Insofar as the first of these principles was found compelling, narrow participation would reduce to participation *tout court*. The other three notions, however, identify modes of participation whose relationship with participation *tout court* is more contentious, and taking them into consideration may shed further light on the corresponding monotonicity principles.⁴⁸

Consider D14. To partially participate in an event is to have a part that participates in that event. This is the case illustrated by the example of Socrates and Diotima. While their sum may not qualify as a *bona fide* participant in the dialogue with Crito, it qualifies as a partial participant. It so qualifies thanks to Socrates' participation. We may stress the difference by saying that Socrates plus Diotima, unlike Socrates, is a *proper* partial participant in the dialogue⁴⁹:

$$D17 \quad PPPCxy \equiv PPCxy \wedge \neg PCxy \quad \text{Proper Partial Participation}$$

Conversely, consider the example of Socrates' liver. Here is where D15 may help. The liver does not participate in the dialogue. It is nonetheless a part of Socrates, who is a *bona fide* participant, and in this sense the liver itself may be said to be a *proper* indirect participant in the dialogue.

$$D18 \quad PIPCxy \equiv IPCxy \wedge \neg PCxy \quad \text{Proper Indirect Participation}$$

Now, we saw that the Left Monotonicity principles P21 and P22, i.e. P21* and P22*, are dubious. But obviously the following variants hold (by definition):

T4	$PCxy \wedge Pxz \rightarrow PPCzy$	<i>Left Upward Partial Monotonicity</i>
T5	$PCxy \wedge Pzx \rightarrow IPCzy$	<i>Left Downward Indirect Monotonicity</i>

⁴⁸ It is an interesting question whether any such notions are even more fundamental and should be taken as primitives instead of *PC*. We won't address this question here, though it is worth noting that it mirrors a question that often arises when parthood structures are at issue, e.g., in the theory of location (Casati and Varzi [14], ch.7, Parsons [91]).

⁴⁹ Or perhaps even Socrates is a proper partial participant? After all, he only participates through (say) his head and gesticulating arms. We'll come back to this question shortly.

Moreover, given the transitivity of P , A6, the following principles hold, too.

T6	$PPC_{xy} \wedge P_{xz} \rightarrow PPC_{zy}$	<i>Partial Left Upward Monotonicity</i>
T7	$IPC_{xy} \wedge P_{zx} \rightarrow IPC_{zy}$	<i>Indirect Left Downward Monotonicity</i>

These four conditionals may therefore be taken as the natural substitutes for P21 and P22. By contrast, none of the following conditionals is provable from the basic axioms even assuming classical mereology and, indeed, each is vulnerable to counterexamples:

P38	$PPC_{xy} \wedge P_{zx} \rightarrow PPC_{zy}$	<i>Partial Left Downward Monotonicity</i>
P39	$IPC_{xy} \wedge P_{xz} \rightarrow IPC_{zy}$	<i>Indirect Left Upward Monotonicity</i>
P40	$PPC_{xy} \wedge P_{zx} \rightarrow IPC_{zy}$	<i>Mixed Downward Monotonicity</i>
P41	$IPC_{xy} \wedge P_{xz} \rightarrow PPC_{zy}$	<i>Mixed Upward Monotonicity</i>

The sum of Socrates and Diotima is a (proper) partial participant in the dialogue with Crito, but Diotima's liver, though part of the sum (again by transitivity), plays no role in the dialogue, not even partially or indirectly. Socrates' liver is a (proper) indirect participant in the dialogue, but although it is part of its own sum with Diotima, this sum does not participate in the dialogue at all.

As for the last notion—the relation of oblique participation introduced by D16—its interest lies precisely in the fact that it doesn't warrant participation *tout court*, as we saw in connection with P23. It is certainly not the case that participating in an event entails participating in all of its subevents. What is true, however, is that it always entails participating in its subevents obliquely:

T8	$PC_{xy} \wedge P_{zy} \wedge E_z \rightarrow OPC_{xz}$	<i>Right Downward Oblique Monotonicity</i>
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Again, this is just a definitional truth. But it captures one important sense in which even the monotonicity pattern expressed by P23 can be recovered. Although most soldiers in World War I did not take part in the Somme Offensive, we may still want to say that they were more closely involved in that battle than Socrates or Cicero, who did not participate in the war at all. And although Cicero himself did not participate in the stabbing of Caesar, we may still want to say that he was more closely involved in that murderous event than Socrates or the soldiers, since Cicero participated in the rebellion of which the stabbing was part. One reason for drawing such distinctions is that they bear on attributions of responsibility, just as the Law distinguishes between, say, the accomplice on lookout and a mere by-stander with regard to their liability for the robbery inside the bank. And one way of expressing the relevant differences is precisely by imputing or denying oblique participation status. Of course, in the presence of Upward E -Involvement (P27), the contrast would collapse, as any event participant would participate obliquely in every event. Generally speaking, however, the contrast is significant and T8 is informative. Moreover, the following stronger principle will hold (again, by the transitivity of P), showing that oblique participation is fully monotonic in the relevant sense:

T9 $OPCxy \wedge Pzy \wedge Ez \rightarrow OPCxz$ *Oblique Right Downward Monotonicity*

The following consequences are also worth noting:

T10 $OPCxy \wedge PCzy \rightarrow \exists w(PCxw \wedge NPCzw)$ *Oblique Narrowness*

T11 $NPCxy \wedge PCzy \rightarrow \exists w(PCxw \wedge OPCzw)$ *Narrow Obliqueness*

If Cicero participated obliquely in the stabbing of Cesar, which involved Brutus as a participant, then, *ipso facto*, Brutus himself participated narrowly in some events involving Cicero, e.g., the rebellion against Caesar. And if Brutus participated narrowly in the rebellion, then, *ipso facto*, Cicero himself participated obliquely in some events involving Brutus, e.g., the stabbing of Caesar.

3.5 Strengthenings

There are other useful distinctions one may introduce at this point. In particular, consider the relations defined by replacing each existential clause in each of D13–D16 with the corresponding universal generalization⁵⁰:

D19 $WPCxy \equiv Ey \wedge \forall z(Pzy \wedge Ez \rightarrow PCxz)$ *Wide Participation*

D20 $GPCxy \equiv \forall z(Pzx \rightarrow PCzy)$ *Global Participation*

D21 $SPCxy \equiv \forall z(Pxz \rightarrow PCzy)$ *Strong Participation*

D22 $EPCxy \equiv Ey \wedge \forall z(Pyx \wedge Ez \rightarrow PCxz)$ *Expansive Participation*

For example, since you participate in every part of your life, and every part of you participates in your life, we may say that you participate in your life widely as well as globally. And if we agree that everything of which you are part participates in your life, then you strongly participate it, just as you expansively participate in your life if that means participating in every larger event of which your life is part.

Clearly, each of these relations is stronger than the corresponding one defined in D13–D16 and, indeed, their logical links with participation *tout court* are reversed: whereas each relation in D19–D22 implies *PC* (by the transitivity of *P*), the converse implications need not hold. We may therefore ask whether any such implication should be assumed independently as an axiom:

P42 $PCxy \rightarrow WPCxy$ *Wideness*

P43 $PCxy \rightarrow GPCxy$ *Globalness*

P44 $PCxy \rightarrow SPCxy$ *Strongness*

P45 $PCxy \rightarrow EPCxy$ *Expansiveness*

⁵⁰ Some of these notions are occasionally discussed in the literature. For instance, the difference between wide and narrow participation is akin to the difference between loose and strict participation in Costa [24].

As it turns out, the answer to this question is already on the table. Each of P42–P45 expresses a necessary condition for participation to obtain. But these conditions, taken in reverse order, are easily seen to be equivalent to the sufficiency conditions expressed by P20*–P23*, hence to the four monotonicity principles P20–P23. That is, Wideness is equivalent to Right Downward Monotonicity, Globalness to Left Downward Monotonicity, Strongness to Left Upward Monotonicity, and Expansiveness to Right Upward Monotonicity. (In the second and third cases, the equivalence is purely logical; in the first and last cases, it depends on the Participation axiom A11.) Thus, our remarks from the previous two sections carry over accordingly. In particular, just as we found it plausible to suppose that narrow participation is sufficient for participation *tout court* (P20*), it is likewise plausible to suppose that expansive participation is necessary (P45); and just as oblique participation is not sufficient (*contra* P23*), wide participation is not necessary (*contra* P42). The remaining two cases, however, are less clear-cut. We have that P43 and P44 are equivalent to the monotonicity principles P22* and P21* (respectively), hence to P22 and P21. The latter principles were found problematic. Reexamining them under the alternative but equivalent guise afforded by P43 and P44 may therefore be instructive.

For instance, it now becomes clearer why P21 and P22 are mutually incompatible. In the equivalent formulations corresponding to P21* and P22*, those principles state that partial participation and indirect participation are sufficient for participation *tout court*. In the new versions corresponding to P44 and P43, they state that strong participation and global participation are necessary. Thus, we see now that their conjunction would imply that partial participation is sufficient for global participation while strong participation is necessary for indirect participation. This is untenable. In fact, it is flatly inconsistent with the following obvious theorems:

T12	$PPPCxy \rightarrow \neg GPCxy$	<i>Proper Partiality</i>
T13	$PIPCxy \rightarrow \neg SPCxy$	<i>Proper Indirectness</i>

Reading P21 or P22 in terms of global and strong participation also helps bring into focus the full import (and limits) of both forms of monotonicity. For instance, the main concern about P22 (Left Downward Monotonicity) was that it rules out a number of cases where participation seems to occur, as with Socrates' participating in the dialogue with Crito despite his liver's playing no role. As the equivalent formulation in P43 makes clear, this is really a concern about whether global participation is necessary for participation *tout court*. But once we frame it this way, it is no longer obvious that the sum of Socrates and Diotima (or, for that matter, the sum of Socrates and any other entity) should not also count as participating in the dialogue. Formally, the mode of participation is the same in both cases. So the concern really turns into a challenge—the challenge of drawing a principled line between those cases where global participation is not required (Socrates in the dialogue) and those where it is (Socrates plus Diotima, etc.).⁵¹ Similar considerations

⁵¹ This is the issue anticipated in note 49. Of course, part of the problem stems from the assumption that there exist such things as Socrates plus Diotima in the first place, which one might reject (see note 45). Trading the Unrestricted Fusion axiom of classical mereology for a weaker fusion axiom would reduce the problem, except that it comes with a notoriously difficult challenge of its own: the challenge of drawing a principled line between those cases where composition obtains and those where it doesn't. See again Markosian [80].

apply to P21 (Left Upward Monotonicity). The main worry about this principle was that it runs counter a number of cases where we might want to say that participation does *not* occur, as with the sum of Socrates and Diotima in relation to the dialogue with Crito. As the equivalent formulation in P44 makes clear, this is really a worry about the necessity of strong participation for participation *tout court*. And once we see it this way, the worry about P21 turns again into the challenge of drawing a principled line—the line between those cases where strong participation is necessary and those where it isn't.

3.6 Completing the Map

Regardless of which principles we decide to endorse, the modes of participation defined in D19–D22 combine with those of D13–D16 to provide a representative taxonomy of the main ways in which something can participate in an event. There are four last possibilities one might consider, corresponding to the converse quantificational patterns:

D23	$BPCxy \equiv PCxy \wedge \forall z(PCxz \rightarrow Pzy)$	<i>Binding Participation</i>
D24	$UPCxy \equiv PCxy \wedge \forall z(PCzy \rightarrow Pzx)$	<i>Upper Participation</i>
D25	$LPCxy \equiv PCxy \wedge \forall z(PCzy \rightarrow Pxz)$	<i>Lower Participation</i>
D26	$RPCxy \equiv PCxy \wedge \forall z(PCxz \rightarrow Pyz)$	<i>Requisite Participation</i>

(The additional condition $PCxy$ is needed in each case to prevent the relation from holding vacuously.) Each of these relations corresponds to modes of participation that are genuinely distinct from the ones considered so far.

To be sure, three such modes—the first, third, and fourth—are so strict as to be virtually unattainable. The relation of binding participation defined in D23 requires y , the event, to include among its parts every other event in which x participates. Insofar as something can participate in a number of mutually disjoint events,⁵² this means that $BPCxy$ can only hold when y is an abnormal, scattered fusion. Similarly, the relation of requisite participation defined in D26 requires y to be part of every other event in which x participates, a condition that is bound to be violated whenever x participates in mutually disjoint events. As for the relation of lower participation defined in D25, it requires x to be part of every participant in y , which is rarely the case. Never mind the dialogue between Socrates and Crito, who obviously have no parts in common. Even a seemingly simple event such as the spinning of a small sphere will involve disjoint participants, e.g. the top half of the sphere and its remainder, the bottom half. Indeed, within the framework of classical mereology, something can be part of every participant in a given event only if those participants form a linear parthood chain. While not impossible, that is hardly an interesting taxonomic case.

⁵² Never mind events occurring on different occasions (in which case the worry might dissolve in a time-sensitive framework; see Sect. 5.1). Absent P16 (hence P8), it is possible for something to participate in disjoint events simultaneously. For example, Socrates might be participating (as an agent) in his dialogue with Crito, which takes place in his jail cell, while also participating (as a patient) in certain accusations being made against him elsewhere.

The relation of upper participation defined in D24 is rather demanding, too, but more interesting. It requires a participant to comprise every other participant, which means that UPC_{xy} will hold only when x is in some sense a “maximal” participant in y . This is an intuitive notion. With reference to the dialogue with Crito, for instance, Socrates’ head and gesticulating arms participate in the event, but neither is a maximal participant in the relevant sense, since neither is part of the other. Indeed, not even Socrates as a whole qualifies, since Crito is not part of him. (Let us set aside the Globalness principle P43 for the sake of simplicity.) Does the dialogue, then, have *any* maximal participant? That depends once again on which bridging principles we adopt. Given the Additivity principle P29, the mereological sum of Socrates and Crito would qualify as a participant, and since this sum includes every other participant in the dialogue (or so we may suppose), it would indeed count as maximal in the relevant sense; anything larger would at most qualify as a proper partial participant. Actually, given the antisymmetry of parthood (A5), the sum of Socrates and Crito would be *the* maximal participant in the dialogue. This is a general fact worth recording. Given only the basic axioms of Sect. 2, upper participants are always unique:

$$T14 \quad UPC_{xy} \wedge UPC_{zy} \rightarrow x=z \quad \text{Upper Uniqueness}$$

Thus, given the Theme Participation principle P31, the upper participant of an event would simply be the event’s theme, i.e., the fusion of all participants:

$$P46 \quad UPC_{xy} \leftrightarrow x=\tau y \quad \text{Upper Maximality}$$

Insofar as upper participants are participants, then, they may be thought of as maximal in the algebraic sense: each qualifies as the least upper bound, relative to parthood, of the collection of entities that participate in the relevant event.⁵³ This should be distinguished from another sense in which an event participant may be thought to be maximal, namely, when it is not part of any other participant in the same event. This second sense can be defined formally as follows:

$$D27 \quad MPC_{xy} := PC_{xy} \wedge \neg \exists z (PC_{zy} \wedge PP_{xz}) \quad \text{Maximal Participation}$$

Clearly, every upper participant is maximal in this sense, too, i.e., the following conditional holds so long as P is antisymmetric:

$$T15 \quad UPC_{xy} \rightarrow MPC_{xy} \quad \text{Maximality}$$

The converse conditional, however, need not hold short of assuming composition principles such as Left Additivity. If Socrates and Crito participate in the dialogue but their sum does not, both qualify as maximal participants in the sense of D27 even though neither is an upper participant in the sense of D24.

⁵³ This is the definition of ‘maximal participant’ found in most literature, following Masolo et al. [81]. See note 30.

At this point we may conclude by mentioning the natural dual to D27, corresponding to the relation of minimal participation that obtains when a participant includes no other participants as proper parts:

$$\text{D28} \quad \text{MIPC}_{xy} \equiv \text{PC}_{xy} \wedge \neg \exists z (\text{PC}_{zy} \wedge \text{PP}_{zx}) \quad \text{Minimal Participation}$$

Thus, for example, while Socrates may count as a *bona fide* participant in his dialogue with Crito, he doesn't count as a minimal participant; some of his proper parts, such as his head and gesticulating arms, participate as well.

Minimal participation is particularly significant insofar as minimal participants have often been invoked, albeit informally, for the purpose of determining the location of events.⁵⁴ Of course, the notion is prone to vagueness, due to the relative indeterminacy of *PC* itself. (Which parts of Socrates, exactly, were involved in the dialogue with Crito?) Yet this sort of vagueness afflicts many other modes of participation discussed above, including maximal participation.⁵⁵ Regardless of how *PC* is precisified, D28 applies and *MIPC* is no less well-defined than *MPC*. In particular, it's clear that all mereologically atomic participants are *perforce* minimal, and that a participant is both maximal and minimal if and only if it is the sole participant in the event.

$$\text{T16} \quad \text{PC}_{xy} \wedge Ax \rightarrow \text{MIPC}_{xy} \quad \text{Atomistic Participation}$$

$$\text{T17} \quad \text{MIPC}_{xy} \wedge \text{MPC}_{xy} \leftrightarrow \forall z (\text{PC}_{zy} \rightarrow z=x) \quad \text{Unique Participation}$$

4 Developments, II – Existential Principles

So much for bridging principles and fine-grained distinctions.⁵⁶ What about principles asserting the existence of participation facts? So far, we have made no assumptions to rule out the possibility that participation is an empty relation. We could, of course, do so explicitly by stipulating that something participates in something.

$$\text{P47} \quad \exists x \exists y \text{PC}_{xy} \quad \text{Non-emptiness}$$

But there are other, more interesting options. In particular, two natural suggestions would be that every object participates in some event and that every event has some participant. Formally:

⁵⁴ See e.g. Davidson [32], Lombard [79], and Carter [12] for classic treatments.

⁵⁵ On these issues, see Borghini and Varzi [7], §2, and Pustejovsky [97].

⁵⁶ There is, of course, room for additional principles and distinctions, especially when it comes to the simultaneous treatment of participant mereology and event mereology. To borrow an example from Davis and Barrett [35], consider the inference from “I shook a link of the chain”, which is about a motion event involving a specific chain link as participant, to “I touched the chain” (even if I didn't shake it), which is about a touching event with the whole chain as participant. Here, again, the linguistic literature inspired by Krifka [71, 72] is especially relevant, though delving into the details would take us too far afield.

P48 $Ox \rightarrow \exists yPCxy$

Heraclitism

P49 $Ex \rightarrow \exists yPCyx$

Kimism

As our labels suggest, these principles are inspired by popular metaphysical views. Indeed, their counterparts for the relation of universal participation have a long and distinguished pedigree: P48 corresponds to the thesis that every object participates in at least one universal (thus excluding the possibility of bare particulars⁵⁷) while P49 corresponds to the thesis that every universal is instantiated or exemplified by some object (a core tenet of the Aristotelian conception of universals as immanent entities, as opposed to the Platonic conception of transcendent forms⁵⁸). The event-participation versions are no less significant. We shall consider them in turn.

4.1 Heraclitism

The first principle, Heraclitism, is so named for its affinity with Heraclitus' $\pi\acute{\alpha}\nu\tau\alpha \rho\epsilon\tilde{\iota}$.⁵⁹ A more accurate formulation of Heraclitus' dictum would, of course, require a temporal quantification, to ensure that everything is *always* involved in some on-going event or process. The same is true of other views that may be associated with P48, as with Sartre's contention that "to be is to act, and to cease to act is to cease to be" ([108], p. 556/476). We shall address temporal considerations in the next section. For now, we just want to see how the assumption of Heraclitism in its present form interacts with the rest of the framework discussed so far.

One important remark concerns the conceptual strength of P48 *vis-à-vis* the basic theory of Sect. 2. To begin with, it's clear that P48 would make the Event Existence axiom A2 redundant: given the Object Existence axiom, A1, the antecedent of P48 is satisfiable and the consequent implies the existence of some event by the Participation axiom P10. Moreover, note that the conjunction of P48 with the Object Participation principle P4 amounts to the following biconditional.

P50 $Ox \leftrightarrow \exists yPCxy$

Heraclitean Objecthood

Thus, a Heraclitean who thought that only objects can qualify as participants could actually dispense with both principles and simply introduce the predicate *O* by definition. Objects would be those things that participate in some event, and P4 and P48 would follow as theorems along with A2. In addition, recall that the Exclusion axiom A3 together with the Totality principle P1 amount to the following:

⁵⁷ Cf. Sellars's [115] argument that bare particulars are impossible, since everything is bound to enjoy at least "logical" properties such as, say, self-identity.

⁵⁸ Or, in contemporary philosophy, the conception championed by Armstrong [3] as opposed to Russell [106].

⁵⁹ In Simplicius' memorable formula (*On Aristotle's Physics*, VIII, 8, ad 265a2–12).

P51 $Ex \leftrightarrow \neg Ox$

Eventhood

A Heraclitean who endorsed Totality might therefore formulate their view by introducing E , too, by definition and recover both A3 and P1 as theorems along with A2, P4, and P48. The entire theory could then be expressed solely in terms of P and PC .

A second remark concerns the interaction of Heraclitism with the bridging principles of Sect. 3. Here the import of P48 emerges most clearly in the context of reductive accounts. In particular, the conjunction of P48 with the Participation Inclusion principle P8—the thesis that participation is a kind of parthood—would immediately imply that every object is a proper part of some event, while its conjunction with the Inverse Participation Inclusion principle P9 would imply that every object has a proper part that is an event:

P52 $Ox \rightarrow \exists y(Ey \wedge PPxy)$

Parthood Heraclitism

P53 $Ox \rightarrow \exists y(Ey \wedge PPyx)$

Inverse Parthood Heraclitism

(In both cases, the implication would rely also on the Exclusion and Participation axioms, A3 and A11.) Thus, objects and events would be mereologically related even though, ontologically, the two categories are disjoint. In addition, P52—and therefore P8—would have the consequence that the universe, $\mathcal{U}$, cannot be an object while P53—and thus P9—would entail that no atom can be an object, either.

A third sort of consideration concerns the possibility of extending the Heraclitean thesis P48 in various ways. For instance, consider the Kantian-Aristotelian view that no event is casually isolated: all that happens is either a cause or an effect of something else. If causes and effects are events, and if causal transactions are themselves construed as (second-order) events, as mentioned earlier, the view would imply that every event participates in some causing event, justifying the following variant of P48:

P54 $Ex \rightarrow \exists yPCxy$

Event Heraclitism

And if the two categories of objects and events are taken to exhaust all there is, as in P1, then P48 and P54 together would amount to the following general principle, where the antecedent is dropped altogether:

P55 $\exists yPCxy$

General Heraclitism

These principles, however, are significantly stronger than P48. For example, it is easy to see that P54 (and therefore P55) is incompatible with the Participation Inclusion principle P8. For P54 implies that the universal event $\mathcal{E}$ participates in something, y , and by the Participation axiom A11, y must be an event, hence a part of $\mathcal{E}$. Assuming P8, $\mathcal{E}$ would in turn have to be part of y , hence identical with y owing to the antisymmetry of P (axiom A5). But then $\mathcal{E}$ would be participating in itself, contradicting the irreflexivity of PC . By contrast, it's worth noting that the conjunction of P54 or even P55 with the Inverse Participation Inclusion principle P9

would remain consistent, delivering the obvious counterpart of P53 (hence the non-atomicity of events).

P56 $Ex \rightarrow \exists y(Ey \wedge PPyx)$ *Inverse Parthood Heraclitism for Events*

There are other noteworthy incompatibilities. For example, we have just seen that P54 implies that E participates in one of its parts, so Event Heraclitism is incompatible with P19, the Inverse Mereological Exclusion principle. More importantly, since E cannot participate in itself, Event Heraclitism is also inconsistent with the Right Upward Monotonicity principle P20. *A fortiori*, all of this is true of General Heraclitism well. It is an interesting question, then, how far Heraclitism can be pushed in the context of theories stronger than the basic theory of Sect. 2.3, considering e.g. variants of P54 and P55 based on more specific relations such as partial and indirect participation.

Finally, there are two broadly metaphysical aspects of Heraclitism worth noting—one concerning *causation*, the other *persistence*. On the first point, the orthodox view holds that the relata of causal transactions are events [31]. However, there are also agent-causation theories according to which participating agents may themselves serve as causes [15, 88, 129]. Heraclitism and Event Heraclitism may help reconcile these two views: if every agent participates in some event, and any such event, insofar as it causes another, participates in a causing, it follows by Transitivity that every agent participates in some causing. This captures a reasonable compromise. It just remains to be seen whether the agent participates in the causing in the thematic role Agent.

As for persistence, the notable aspect is Heraclitism's particular appeal once one moves beyond the established endurance/perdurance divide. Costa [24], for instance, distinguishes between *immanent* and *transcendentist* theories of persistence. Immanent theories embody the traditional view that persisting objects are literally located in time, whether by enduring or by perduring. By contrast, transcendentist theories maintain that objects persist, not by being themselves located in time, but by participating in temporally located events.⁶⁰ If this view is accepted, then Heraclitism supplies the needed metaphysical foundation: every persisting object must participate in some event.

4.2 Kimism

Turning now to the second existential principle listed above, P49, the label 'Kimism' is a tribute to Kim's theory [67, 68], which we have already mentioned repeatedly along with Peterson's [95] extension to higher-order events. On this theory, every event consists of particulars exemplifying certain properties at certain times, and those particulars qualify as participants. Thus, every event must have participants, which is exactly what P49 says.⁶¹

⁶⁰ On transcendentist theories, see also Costa and Giordani [25]. Other non-immanentist theories include Simons [119] and Fine [38].

⁶¹ P49 may also be associated with other views, e.g. views that construe all events as changes, as in Lombard [79] or Cleland [20].

Philosophically, of course, Kimism is open to the objection that participantless events do not seem inconceivable [10]. Strawson's purely auditory or visual phenomena would be cases in point: "That a flash or a bang occurred does not entail that anything flashed or banged" ([128], p. 46). However, examples of this sort hinge crucially on how one construes the category of admissible participants. Surely no ordinary objects are involved in a flash or a bang; yet there may be more participants than meet the eye. Following Bennett [5], §5, for instance, a Kimian could respond that a flash occurred insofar as certain photons moved, a bang occurs because of how air undulated; and so on. Or one might invoke participants that belong themselves to the event category: a movement of photons reaching a certain threshold, an air undulation reaching a certain threshold, etc.

Be that as it may, formally the assumption of Kimism would have a number of notable consequences. The most important is that the following biconditional would become provable:

$$P57 \quad Ex \leftrightarrow \exists y PCyx \quad \text{Kimian Eventhood}$$

Thus, Kimism would allow for the introduction of E by definition: events are those things that have participants. This is perfectly parallel to the Heraclitean option of defining O via P50, though without resorting to contentious principles such as Object Participation; given P49, P57 follows directly from the Participation axiom A11. With E defined in this way, the whole theory could therefore be streamlined. A11 itself, along with P49, would become provable and the pure axioms for PC would reduce to A12 (or even A12') and A13. Furthermore, if one held that objects and events are all there is (contrary to Kim's own view), then again one could define O as well, paralleling P51:

$$P58 \quad Ox \leftrightarrow \neg Ex \quad \text{Objecthood}$$

and the Exclusion axiom A3 would likewise become redundant. No wonder Kimism is such an attractive theory in the context of two-category ontologies. Indeed there are ways of recovering O even in less exclusive contexts. For instance, suppose we also endorse the Heraclitean principle P48. Then it would suffice to suppose that objects and events exhaust the range of things that can serve as participants:

$$P59 \quad PCxy \rightarrow Ox \vee Ex \quad \text{Exclusive Participation}$$

This would have the following immediate consequence:

$$P60 \quad Ox \leftrightarrow \exists y PCxy \wedge \neg Ex \quad \text{Relative Objecthood}$$

and one could rely on this biconditional to define O .

Finally, like Heraclitism, Kimism has a number of consequences for the bridging principles of Sect. 3. For instance, it follows immediately that the conjunction of P49 with the Participation Inclusion principle P8 rules out the possibility of mereologically atomic events, while its conjunction with the Inverse Participation

Inclusion principle P9 would imply that the universe cannot be an event. Another consequence is that the Left Upward Monotonicity principle P21 would entail (via P32) that the universe participates in every event.

4.3 Hybrid Participation

One last observation is in order. We have been assuming that both objects and events can serve as participants. Suppose we also adopt a mereological framework strong enough to include the Unrestricted Fusion axiom A8. This axiom entails the existence of gerrymandered fusions of all sorts, including hybrid fusions composed of both objects and events, and there seems to be no compelling reason to suppose that such fusions behave like ordinary objects or events. The question then arises: how do they behave with regard to the participation relation that we are trying to characterize?

Admittedly, here is where the formal machinery appears to generate more questions than answers. There is no ordinary sense in which we speak of such things as, say, the mereological sum of Socrates and his dialogue with Crito, or the sum of Cicero and World War I, hence no ordinary sense in which such things can be said to serve as participants or to have participants themselves.⁶² Any account of their behavior will *perforce* be a matter of sheer theoretical stipulation.

To be clear, the issue does not concern the behavior of transcategorical fusions as such. Some are perfectly unproblematic, and indeed we have already mentioned theories according to which even ordinary objects are entities of this kind, as in Koslicki's [70] mereological hylomorphism. The issue arises specifically in connection with hybrid entities comprising objects and events. For the sake of illustration, consider the simple case of hybrid binary sums, defined as follows:

$$\text{D29} \quad HSzxy := Ox \wedge Ey \wedge z = x + y \quad \text{Hybrid Sum}$$

With the exception of the Dissectivity principles P2 and P3, all other principles discussed so far are compatible with the possibility that a hybrid sum qualifies as either an object or an event. Accordingly, nothing precludes such entities from entering into the participation relation. In particular, any hybrid that counts as an event may serve as the second relatum. The question is whether the involvement of hybrid sums in the participation relation should obey specific restrictions. Since any such restrictions would, in our opinion, be entirely stipulative, we shall not delve into the details here. A complete account, however, would eventually need to address such matters in some fashion.

⁶² At least generally. If participation itself is reduced to a kind of parthood or to its inverse, as in P8 and P9, and if Socrates counts as a participant in his dialogue with Crito, the sum of Socrates and the dialogue would be no more than the dialogue (since $Pxy \rightarrow x + y = y$) or Socrates (since $Pyx \rightarrow x + y = x$), respectively. A sum such as Cicero plus World War I, however, would still be a baffling "ontological chimera" (in the words of Simons [120], p. 116).

5 Extensions

The preceding sections have outlined what we take to be the central issues and options in the study of the formal interplay between the relation of event participation and the mereological relation of parthood. Officially, we have not assumed the latter to be governed by the axioms of classical mereology, but in a number of cases our remarks rely crucially on those axioms. Since classical mereology is not uncontroversial, it's clear that the picture may change considerably if those axioms are rejected, as in weaker, non-classical mereological systems.⁶³ We leave a proper treatment of such possibilities for another occasion. Here we conclude by sketching instead a couple of ways in which the picture can be extended by enriching the logico-linguistic framework on which it rests. We are thinking specifically of ways to extend the framework along two important dimensions that we have thus far mentioned only in passing: time and modality.

5.1 Time

Events take time, and participation in an event is often a matter of participating in it for a certain period of time. Socrates' conversation with Crito lasted a few hours, and Socrates participated in it for the entire duration (as a speaker or as a listener). By contrast, the soldiers who perished in the Somme Offensive participated in World War I only for a limited period, and if you arrived when Cordelia was proclaiming "Nothing, my Lord" and left immediately after, you attended *King Lear* for just a few seconds. Similarly for parthood, at least insofar as some entities, such as objects, need not be composed of the same parts throughout their entire existence. (Whether the same can be said of perduring events is less clear, though it remains true that the parts of a temporally extended event need not be all present at the same times.) To do justice to such facts, we may therefore wish to revisit the whole framework by construing both *PC* and *P* as three-place relations, '*x* participates in *y* at *t*' and '*x* is part of *y* at *t*', or perhaps '*x* participates in *y* through *i*' and '*x* is part of *y* through *i*', where the third argument ranges over moments of time or over intervals of time, respectively.⁶⁴ This would require several adjustments.

To begin with, we would need some way to refer to times. Fixing on moments rather than intervals for the sake of illustration, this can be achieved by enriching

⁶³ For a survey of such theories, see again [28], chs. 3–5.

⁶⁴ Both options are common in the formal-ontology literature, following Schlenoff et al. [110] and Masolo et al. [81], respectively. To be sure, insofar as events are thought of as perduring entities, one could stick to the binary *PC* relation of the previous sections and construe the participation of something *x* in an event *y* at a time *t* as the participation of *x* in the *t*-part of *y*, defined as the fusion of all events that are part of *y* at *t* and that are present (in the sense specified below) at *t* and at no other time. Similarly for participation through an interval *i*. However, the use of a ternary participation relation maximizes the parallels with ternary parthood and is philosophically more neutral (see note 3). Moreover, the very idea that temporal extension involves temporal parts in this sense is controversial; see e.g. Parsons [90].

the non-logical vocabulary with a new primitive monadic predicate, say T ('is a time'). In addition, we would need some means of specifying whether a given object or event exists or occurs at a given time. This can be done by adding a further binary predicate, say PR ('is present at'). These new predicates would, of course, need to be properly axiomatized. Among other things, we would need axioms to fix their intended relationship, such as

$$A14 \quad PRxt \rightarrow Tt \quad \text{Temporal Presence}$$

(things can only be present at times), and the two existence axioms A1 and A2 would have to be supplemented by specific requirements connecting existence itself (in the quantificational sense) and presence at times. For instance:

$$At1 \quad Ox \rightarrow \exists t(Tt \wedge PRxt) \quad \text{Temporal Objecthood}$$

$$At2 \quad Ex \rightarrow \exists t(Tt \wedge PRxt) \quad \text{Temporal Eventhood}$$

and perhaps also⁶⁵

$$At3 \quad Tt \rightarrow \exists x(Ox \wedge PRxt) \quad \text{Strong Object Existence}$$

$$At4 \quad Tt \rightarrow \exists x(Ex \wedge PRxt) \quad \text{Strong Event Existence}$$

In addition, the Exclusion axiom A3 would have to be supplemented with similar axioms asserting the exclusiveness of the new ontological category⁶⁶:

$$At5 \quad Tt \rightarrow \neg Ot \quad \text{Object Exclusion}$$

$$At6 \quad Tt \rightarrow \neg Et \quad \text{Event Exclusion}$$

Next, the mereological machinery of Sect. 2.2 would have to be replaced by a suitable axiomatization of the ternary parthood relation P . This is by no means an easy task and we refer to [118], §5.2, and [28], §6.2.2, for details. Among other things, such an axiomatization would need to include an axiom requiring the third relatum to be a time:

$$At7 \quad Pxyt \rightarrow Tt \quad \text{Temporal Parthood}$$

and presumably also axioms requiring that the parthood relation can only obtain between parts and wholes that are present at the relevant times:

⁶⁵ Given A14, the converse of At3 is derivable, so T could actually be introduced by definition. Similarly for At4. The tenability of these further principles, however, depends on one's metaphysical views. For instance, while at least one of At3 and At4 would seem needed on a relationist conception of time, substantivalists might want to reject both (see e.g. [87], ch. 2). Likewise, if one thought that every event involves some change (as in the theories of Lombard [79] and Cleland [20]), and if time without change is possible (Shoemaker [116]), then At4 would be too strong.

⁶⁶ One more reason not to assume Totality (P1) in the basic theory of Sect. 2.

At8	$P_{xyt} \rightarrow PR_{xt}$	<i>Part Presence</i>
At9	$P_{xyt} \rightarrow PR_{yt}$	<i>Whole Presence</i>

In addition, something would have to be said about the structure of time itself. This can be problematic if such structure, too, is construed mereologically, as with atomic vs. gunky time. For our present purposes, we may simply suppose that whatever it is, the structure of time is *not* delivered by the new three-place relation:

At10	$P_{xyz} \rightarrow \neg T_y$	<i>Parthood Preclusion</i>
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Finally, we would need to revisit the basic axiomatization of *PC*. This would be rather straightforward. The three axioms A11–A13 would simply turn into their obvious three-place counterparts:

At11	$PC_{xyt} \rightarrow E_y$	<i>Participation</i>
At12	$PC_{xyt} \rightarrow \neg PC_{yxt}$	<i>Asymmetry</i>
At13	$PC_{xyt} \wedge PC_{yzt} \rightarrow PC_{xzt}$	<i>Transitivity</i>

and the intended reading of the third argument of *PC* could be fixed by additional axioms akin to At7–At9⁶⁷:

At14	$PC_{xyt} \rightarrow T_t$	<i>Temporal Participation</i>
At15	$PC_{xyt} \rightarrow PR_{xt}$	<i>Participant Presence</i>
At16	$PC_{xyt} \rightarrow PR_{yt}$	<i>Event Presence</i>

It might also be good to supplement At11 and At14 with a further axiom requiring explicitly that times are not among those entities that may feature as participants⁶⁸:

At17	$PC_{xyt} \rightarrow \neg T_x$	<i>Participation Preclusion</i>
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These would be the main revisions to the basic framework of Sect. 2. On this basis, all developments of Sects. 3 and 4 would then need to be reworked accordingly. To some extent, this would simply be a matter of reformulating the various principles in terms of their ternary counterparts. But the shift to a ternary participation relation

⁶⁷ As in Schlenoff et al. [110] and Masolo et al. [81]. The second of these axioms, At15, is actually open to doubt. For instance, when *y* is a mental event, it seems possible for something *x* to participate in *y* without being present at the time of *y*'s occurrence. A case in point would be our thinking of Socrates now, an event that involves Socrates as a patient even though he no longer exists. Part of the issue, here, depends on how exactly one understands the notion of presence, particularly whether it requires physical presence. If it does, then At15 is indeed too strong. It could be replaced by the weaker stipulation that at least *some* participant of *y* be present at *t* (a stipulation that could perhaps be refined given a theory of thematic roles).

⁶⁸ This would run against space–time supersubstantivalism (see [121]). However, in the present context supersubstantivalism is already at odds with At5 and At6.

would also generate alternatives that the binary relation cannot distinguish, each of which would have to be assessed on its own grounds.

Thus, with reference to the bridging principles of Sect. 3, each condition could be imported *holus bolus* into the temporal framework by uniformly appending a third variable, t , to each clause involving P or PC (as with the reformulation of A11–A13 as At11–At13). This would deliver a strictly “synchronic” counterpart for each principle. In each case, however, the time variable may also be appended more flexibly, giving rise to a multiplicity of cross-temporal variants. For example, one important sense in which the Right Upward Monotonicity principle P20 was found to be plausible would correspond to its synchronic formulation, namely:

$$\text{Pt1} \quad PC_{xyt} \wedge Pyzt \wedge Ez \rightarrow PC_{xzt} \quad \textit{Synchronic Right Upper Monotonicity}$$

But now we could also articulate the sense in which P20 might have been problematic *vis-à-vis* the relevant extent of the event’s part. For the plausibility of Pt1 need not carry over to its “diachronic” counterpart:

$$\text{Pt2} \quad PC_{xyt} \wedge Pyzt' \wedge Ez \rightarrow PC_{xzt'} \quad \textit{Diachronic Right Upper Monotonicity}$$

Another way of capturing the relevant difference would rest on distinguishing between mere temporary participation and constant participation⁶⁹:

$$\begin{array}{ll} \text{Dt1} & TPC_{xy} := \exists t PC_{xyt} \quad \textit{Temporary Participation} \\ \text{Dt2} & CPC_{xy} := \forall t (PR_{yt} \rightarrow PC_{xyt}) \quad \textit{Constant Participation} \end{array}$$

The examples of the perished soldiers and of your limited attendance to the *King Lear* performance would be cases of temporary participation, whereas Socrates’ engagement in the dialogue with Crito would be an instance of constant participation. And while neither of these notions need be right upward monotonic, a mixed principle might do:

$$\text{Pt3} \quad CPC_{xy} \wedge Pyzt \wedge Ez \rightarrow TPC_{xz} \quad \textit{Mixed Right Upper Monotonicity}$$

Similar considerations could then be extended to every other thesis examined in the foregoing sections. The Heraclitean and Kimian principles P48 and P49, for instance, would admit different formulations depending on the various temporal constraints one might consider. With reference to the basic relation PC , a strong formulation would assert that every object participates in some event or other at every moment of its existence and that every event always has some participant at every moment of its duration, respectively⁷⁰:

⁶⁹ If PC_{xyt} were construed as PC_{xy_t} , where y_t is the t -part of y (see note 64), these notions would reduce to x ’s participation in some or in every temporal part of y , hence to narrow and wide participation, respectively (cf. D13 and D19).

⁷⁰ Both principles are treated as axioms in Borgo and Masolo [8] (see also Borgo and Mizoguchi [9]). The original axiomatization in Masolo et al. [81] assumes instead Pt5 and the weaker Pt6 given below, so it is strongly Kimian and weakly Heraclitean.

Pt4	$Ox \wedge PRxt \rightarrow \exists y PCxyt$	<i>Strong Heraclitism</i>
Pt5	$Ex \wedge PRxt \rightarrow \exists y PCyxt$	<i>Strong Kimism</i>

But weaker formulations could now be distinguished—for example:

Pt6	$Ox \rightarrow \exists y \exists t PCxyt$	<i>Weak Heraclitism</i>
Pt7	$Ex \rightarrow \exists y \exists t PCyxt$	<i>Weak Kimism</i>

5.2 Modality

Modality enters the picture in similar ways. Things happen, but in most cases we take them to happen as a matter of contingent fact. It's not just that some events that actually occurred might not have occurred, just as some existing objects might not have existed. Nor is it only that other events might have happened, just as other objects might have existed. We may want to say (or deny) that participation itself is world-relative, that is, that whether something participates in an event is itself open to some modal variation. Similarly with regard to parthood: we may want to say (or deny) that whether something is part of something else is not rigidly fixed and could receive different answers as we consider different ways the world might have been. One way to make room for such considerations, as with any modal consideration, is obvious enough: we could shift to a suitably richer logical framework, extending our vocabulary with the familiar modal operators of necessity and possibility. This would allow us to stick to the basic parthood and participation relations of Sects. 2–4 and deal with the relevant questions within a genuinely modal extension of the basic theory.⁷¹ But we could also follow the strategy just illustrated in connection with time, resorting to suitable ternary relations, 'x is part of y at world w' and 'x participates in y at world w' (reading the unary predicate *T* as ranging over possible worlds) and continuing to work within the framework of standard first-order logic with identity. Here we shall confine ourselves to a few remarks about this second option.⁷²

The formal steps would closely mirror those of the previous section, so we shall not repeat them. Every axiom, principle, and question considered with respect to time admits a straightforward analogue in terms of possible worlds. In addition, however, the modal reading of the third argument of *P* and *PC* would prompt questions that are distinctively modal. Among these, one of the most interesting is whether events have their participants necessarily. Brutus stabbed

⁷¹ Actually, this option is available also with regard to time, though it is rarely considered and, even so, only for the purely mereological component. See e.g. the tensed mereology of Hovda [58]. On modal mereology, see e.g. Uzquiano [132].

⁷² Yet another option would be to construe objects and events as trans-world wholes comprised of modal parts (what Schlesinger [111], calls 'cosmic chunks'). This option, too, would allow one to preserve the binary relations of Sects. 2–4, though its best motivations are usually offered in terms of a five-dimensional metaphysics (e.g. [6], [48], or [135]) and are therefore at odds with the formal concerns of the present paper.

Caesar; but could the stabbing have occurred without Brutus' contribution? Cicero was involved in the rebellion against Caesar; but could the rebellion have taken place without Cicero's participation? It's easy to be confused about such questions, as we may inadvertently shift from intuitions about event types to conclusions concerning event tokens. Surely Caesar could have been stabbed by someone else; but could Brutus' stabbing of Caesar—that specific event that took place in Rome on the Ides of March—have occurred without Brutus' participation? Surely there could have been a rebellion against Caesar that didn't include Cicero; but could the rebellion that actually took place—that particular event—have occurred without him? Thus framed, the questions concern the tenability of the following principle:

$$\text{Pm1} \quad PCxyw \wedge PRyw' \rightarrow PCxyw' \quad \textit{Participation Essentialism}$$

Readers familiar with modal mereology will recognize the similarity with the parallel principle of mereological essentialism (after [18])⁷³:

$$\text{Pm2} \quad Pxyw \wedge PRyw' \rightarrow Pxyw' \quad \textit{Mereological Essentialism}$$

And surely enough, if one endorses a reductive principle to the effect that participation is a kind of parthood, such as the modal counterpart of P8,

$$\text{Pm3} \quad PCxyw \rightarrow Pxyw \quad \textit{Participation Inclusion}$$

the two principles will stand or fall together. Generally speaking, however, Pm1 and Pm2 are mutually independent, and while Mereological Essentialism is often rejected on the grounds of its exceeding rigidity, Participation Essentialism may seem more plausible and should be assessed in its own right.⁷⁴ Moreover, the auxiliary predicates of Sects. 3.4–3.6, or rather their ternary counterparts, allow for the formulation of several variants of Pm2, each of which would call for separate assessment. For instance, Lombard [78] holds that it is the *minimal* participants of an event that are essential to the event's identity. This view corresponds to the following principle,

$$\text{Pm4} \quad MIPCxyw \wedge PRyw' \rightarrow PCxyw' \quad \textit{Minimal Participation Essentialism}$$

where *MIPC* is the ternary variant of the predicate defined in D28. Other views may be expressed in a similar fashion.

⁷³ Mereological essentialism is normally discussed with regard to material objects, but see e.g. Daniels and Goswick [29] for a parallel discussion of the mereology of events.

⁷⁴ Or in relation to questions that arise in the context of specific metaphysical theories. The problem of causal overdetermination would be a case in point. Alf and Beth throw rocks at a window. Beth's rock arrives first, shattering the glass, but the glass would have shattered anyway by effect of Alf's throw. Would the effect have been the same, considering that the participants are partly different (the two rocks being distinct)? See Collins et al. [23].

There are, moreover, several other principles of this sort that one might consider. Just as we may contrast Mereological Essentialism with a dual thesis, to the effect that everything is necessarily part of any whole to which it belongs,⁷⁵

Pm5 $P_{xyw} \wedge PR_{xw'} \rightarrow P_{xyw'}$ *Reverse Mereological Essentialism*

so Participation Essentialism (and its variants) may be contrasted with the dual thesis that participation in an event is itself a matter of necessity:

Pm6 $PC_{xyw} \wedge PR_{xw'} \rightarrow PC_{xyw'}$ *Reverse Participation Essentialism*

Thus, for example, Brutus participated in the stabbing of Caesar; but was this a matter of contingent fact, or was he bound to act as he did, as Pm6 would imply? Did Caesar necessarily have to be involved (and killed) in the stabbing? Evidently, Reverse Participation Essentialism gives expression to a form of fatalism that few philosophers would embrace. Yet fatalism itself comes in a variety of forms and guises, some of which are notoriously difficult to state with precision.⁷⁶ The formal apparatus under consideration might prove fruitful to overcome such difficulties.⁷⁷

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⁷⁵ This view is sometimes known as ‘Holological Essentialism’ (after Ruben [105]). The label ‘Reverse Mereological Essentialism’ is from Koslicki [70], pp. 112ff.

⁷⁶ See e.g. the essays in Fischer and Todd [40].

⁷⁷ These considerations would apply, *mutatis mutandis*, if *PC* were construed as the relation of participation between particulars and universals, in which case Pm6 would express a principle of extreme metaphysical essentialism whereby nothing could enjoy any properties other than the ones it actually has. A parallel treatment of both readings of *PC* might therefore shed some light on the *prima facie* structural similarity between fatalism and extreme essentialism, but also on relevant differences if the other axioms for *PC* differ in the two cases.

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