

A SPECIAL DAVIDSONIAN THEORY OF EVENTS

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Abstract

What is an event? What sort of object are they? How is a given event distinguished from other events and other objects? This thesis on science oriented metaphysics will take Davidson's account of events as its starting point to answer the above questions. It will develop this conception of events into one that is consistent with the special theory of relativity by updating its notions of change, cause and property.

The new concept of a proper property, a generalization of the notion of an invariant, is introduced to solve some of these metascientific problems. Other features of the work include an analysis of the Lorentz force equation as it applies to one family of cases of causation, showing that a use of cause and effect to help individuate events cannot be complete until relativistic features are built into it. I propose that the conception of a proper property will also solve this worry over the nature of causation as it affects the issues of events above. In particular, it will attempt to solve a charge of circularity which has been leveled at Davidson's account.

This property analysis also has the feature that it makes the account of events which started with Davidsonian inspiration (i.e. causes and effects are intimately connected to events) more like Kim's. Kim's account of events is modified on the grounds it does not do justice to our intuitions about changes and events.

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Dedication

This thesis is dedicated to all the friends and correspondents (Harvey Auerback, Robin Breger, Chino, Marjorie Caruso, Andrew Hryckowian, John Mazetier Jr., Jim Prall, Raven, Audrey Yap), family (Mom & Dad, Becky, my late grandfather [1912-2000] - amateur philosopher extraordinaire), colleagues from various institutions (Paul Bartha, Mario Bunge, Kari Coleman, Darcy Cutler, Lisa Fuller, Melinda Hogan, Andrew Irvine, Vic Stenger, Steve Savitt [for checking my relativity theory and co-reading the work], Dave Thomas, Brad Wray) and of course, my supervisor Gary Wedeking, who made this work possible. May everyone who opens this work find truth and beauty in reading it as I did in creating it.

Chapter 1 - Background

This chapter has four parts. In the first part, I set out the issues to be discussed in the rest of the thesis pertaining to events in general terms by way of "frame setting." Then in the second section, I shall briefly explain eight philosophical reasons for this project so as to situate it within the philosophical tradition. In the third section, I defend the scientific relevance of the thesis as befits its status as a work in science oriented metaphysics. The fourth and final section of this chapter shall discuss what I call "the division of labour" as it pertains to events. This section discusses how philosophers have approached issues surrounding events and explains the metaphysical focus of the present thesis. It contrasts the metaphysical approach of the current work with the epistemological and semantic approaches found in other works on events, and draws some methodological morals to be used later. It also cautions as to why this division of labour is important, as it will partially explain my selection of Davidson's work as a starting point for the thesis. This latter topic leads us straight into chapter two.

Section 1 - Frame Setting / Introduction

This section discusses briefly the issues which will be defended and debated in this thesis and how they relate to the existing events literature and other branches of philosophy.

This thesis principally centers around two main questions. These are: what distinguishes events from each other and from other objects¹? (Object here is the basic ontological category to which "everything" belongs.)

¹ It may be noted that I use some philosophical and scientific vocabulary in a way that may be unfamiliar to the reader. The reader is reminded that there is a glossary in appendix I of this text.

But first, what is an event? A happening, occurrence, genuine change. Fallings, kissings, oxidations, lovings, swervings, compressions, and many more are all events. Plato and Socrates might accuse me of giving a "hornet's nest explanation," but giving a precise definition is not easy. I suggest that readers adopt an intuitive understanding to begin with and follow the arguments in the thesis to refine her intuition. In this sense, this work (particularly in chapter 4) can be looked as a protracted implicit definition.

As may be inferred from its title, this work takes Donald Davidson's views (e.g.: 1980 [1967a], 1980 [1969], 1980 [1970a], 1985) on events as its starting point. In Davidson's account, events are concrete particulars, though they are of various kinds, and are distinguished from other events by their causes, effects² and spatiotemporal location of occurrence³. They are distinguished from things by being essentially dynamic in character. However, events are one sort of change in the world, distinguished from certain kinds of merely relational change. Distinguishing events from other objects is the problem I herein call the "identity problem," and distinguishing events from each other is the "individuation problem." By looking at the characteristics of events understood in solving the former problem, we may then proceed to solving the second problem. By looking at the second problem, however, we learn what makes events identical and thus, what sorts of characteristics they have - which feeds back into the first

² It should not be prejudged at this stage whether all events have a cause and effect. This principle of individuation (loosely stated for the moment) does not in itself rule out causeless or effectless events, or events with multiple causes and effects. My theory of events shall take a stand on these issues in due course.

³ Readers familiar with Davidson's views may note that he has actually changed his position over the years. In chapter two I shall trace this development and I shall discuss why I take this description of Davidson's views to be the one most useful for a starting point.

question. We thus have an example of a virtuous circle.

Leibniz' law does give us a general criterion of identity for any object whatsoever, but this does not allow us to perform the individuation analysis just mentioned precisely because the hypothesis is too strong (or too weak, depending on one's point of view) - i.e., it does not tell us anything about events in specific - and how they are not like other objects. Furthermore, as LePore (1985, pp. 161) points out, having a weaker criterion of individuation of events allows us to avoid "reducing" events to their "constituent" properties, things, etc. As *sui generis* objects they are ontically individuated and identical in their own fashion. This is in line with my (and Davidson's) view that events are a basic ontological category. As we shall see, Davidson considers both the problem of identity and the problem of individuation.

However, Davidson's analysis fails when cases from physics are examined, as we shall see in section four of the third chapter of this thesis. Thus in order for his account to be rendered more useful in a science oriented metaphysics, it must be modified in the light of scientific findings. To accomplish this task, I shall find that it is necessary to revise and add to his account of cause, change and property as they pertain to events. Since this work is only a study of the problem of the individuation and identity of events, I shall remain agnostic on many other details of these metaphysical terms. The goal of this thesis is thus to perform these required revisions while ultimately adopting as much of Davidson's account as possible, and thus answer the questions I began this section with.

These new (to Davidson at least) characteristics which shall be used to modify Davidson's account involves adopting some features of a "property exemplification" view of events. The modified account that results has many features of Kim's (1993). How this is to work is elucidated in chapter four, particularly section four.

Section 2 - Philosophical Relevance

No philosophical problem exists in isolation. This truism should nevertheless remind us that there is some merit to situating the problems of events that will concern us in a larger philosophical context to see what solutions (or lack thereof) would affect an understanding of events and be affected by said understanding.

To this end, let us note that Davidson has provided four diverse¹ philosophical reasons for investigating the issues surrounding the two problems of events above. Let us look at his reasons, unpack them a little, and then examine several of my own. He suggests that there are four philosophical reasons for doing this investigation. First, the notion of event figures prominently in the philosophy of action; second, events figure prominently in many accounts of explanation in epistemology; third, issues over the identity of events fuel debates concerning the various 'identity theories' of mind; fourth, in semantics certain sentences cannot be easily analyzed as to their meaning (and truth conditions) unless there are such objects as falls, strollings etc. (1980 [1969], pp. 164 ff.). As we shall see in chapter 2, Davidson develops this latter point into an argument in favour of postulating the existence of events.

The first of Davidson's reasons can be understood if one recalls the possibility that actions are one kind of events. (It is normally taken that actions are events, except by those (e.g. Chisholm 1985) who deny that there are events.) Knowing how to individuate events and hence actions allows the action theorist to elucidate such notions as the various species of responsibility, the will, etc.

¹ The fact that this list is diverse should not raise any concern - I shall not actually deal with the outcome of the new view developed on all these areas of investigation in this thesis - that is work for another time.

The notion of events figures prominently in accounts of explanation as follows: to explain a fact is to exhibit why it is the case and why it is not otherwise. A change is one sort of common fact to explain, and many changes are events. We shall see, whether certain kinds of changes are events and obtain an ontological category which will affect our accounts of explanation. One's views on change also inform our understanding of events; I shall discuss this issue in great detail when I discuss inertia and Newton's laws in chapter four.

In philosophy of mind, Davidson's third suggested use for our understanding of events, there is debate over in what sense mental events are material (or physical?) events. To evaluate claims of this sort, we need a robust conception of event identity. Davidson performs a mind-body event analysis himself in 1980 [1970b]. Note that this use of events is not limited to any particular side of this debate; to deny or affirm the thesis of identity requires use of events. If one holds that mental events are not material, for instance, one must develop an account of events which permits two radically distinct ontological kinds and explain how they interact (or do not, but appear to.)

Davidson's final area where an understanding of events plays a philosophical role is in the context of semantics. English, when analyzed (as Davidson himself did starting in his 1980 [1967a]) suggests that we speak as if there were such objects, hence, to retain this weakly realist semantics we ought to postulate events. In chapter 2, I shall investigate how this semantic and logical analysis suggests a metaphysics. Of course, were it to turn out that events were nonexistent or radically unlike how we implicitly talk about them, our semantics would have to be revised. Thus either way, investigating events would affect our semantics. For instance, if there were no events, this would weaken a realist semantics, as a realist semantics appears to require the existence of events. These final

reasons shall also occupy us somewhat in chapters two and three as I suggest one might think that semantics is more connected to metaphysics than the current author does.

Davidson has thus provided us with two metaphysical, one epistemological and one semantic reason to study events. However, there are at least four other philosophical (primarily metaphysical) reasons to investigate events that Davidson has not suggested. These reasons, like Davidson's, are other philosophical puzzles and interests that are affected by the study of events. Investigating events must constrain and be constrained by these other areas of inquiry.

Let us look at these now. First, a study of events affects our study of causation and properties. In some conceptions of events (including Davidson's and the one I shall later adopt in section four of chapter four) they are the sole relata of causation. Those who hold that there is something like "fact causation" (or "property causation") shall see that events affect their understanding of these too. Events are ontologically distinct from, but are nevertheless strongly "connected to" properties. The study of events has also led to a greater clarification of the difference between causes and enabling (or initial) conditions (Lombard 1990, pp. 195-196). I shall in turn readopt this distinction to elucidate my conception of events in chapter four.

Second, as stated previously, events are changes of a specific kind. But, many authors (e.g. Davidson 1980 [1967a]; Bennett 1988 pp. 53 ff.) hold that mere relational changes of certain kinds are not events. Thus, our study of events shall shed light on our views of relational properties. It also illuminates our conceptions of intrinsic properties, as this work will emphasize the contrast between the two sorts of properties in a way which is perhaps unfamiliar to some philosophers. (See chapter three, section four for the setting out of this problem and

chapter four, sections one through four for its resolution.) Understanding why some merely relational changes are not events will thus give us a useful but negative component to my *principium individuationis* for events. My solution to the question of "relational events" makes use of my understanding of causation, and hence is dependent on that for support.

Third, understanding events may yield a greater understanding of object persistence in the philosophy of space and time. McCall (1994, pp. 216) has suggested that the different natures of events and things explains their difference in persistence conditions. The conception of events developed herein shall thus help us evaluate the merit of this suggestion. Specifically, his suggestion (1994, pp. 214) that events are necessarily 4 dimensional is adopted in some fashion in the thesis, though they may nevertheless have an infinitesimal (or Planck length) temporal dimension. I shall not specifically draw any morals about persistence, but note that our account of events affects conceptions about what undergoes changes. (See chapter four, section four's discussion of an oxidation-reduction reaction and brief remarks on persistence through changes based thereon.)

Fourth, it should go without saying that a study of events affects our understanding of general ontology. Whether it turns out that events are important objects in the world, the contrary, or anything between, understanding events enriches this general understanding of what objects there are.

Section 3 - Scientific Relevance

Since this work is partly a work in the philosophy of science, it bears investigating what understanding of events is found in science. This takes two distinct forms. One is analyzing the uses of the word "event" as it occurs in scientific contexts. The other is seeing whether the pretheoretic concept from ordinary life seems to be adopted

(to whatever degree) by scientific investigation. (As will be discussed below in section four, this is a "check" on the natural language analysis that many philosophers do.)

These three meanings are as follows: Hawking (1988) uses it throughout to mean both a spacetime quadruple (x,y,z,t) and a happening at said quadruple. Benson (1991, pp. 796 ff), according to Stenger 2000b, uses it the way it is normally used in physics, namely, as a spacetime quadruple. Auyang (1995, pp. 129-132), on the other hand, finds these and another meaning that of a point on a manifold, unhelpful metaphysically. A spacetime quadruple does not do anything, even in the context of substantivism (the thesis that space and time are objects), so this notion does not capture the pretheoretic notion that events are changes. A "happening" at a location is a bit vague, but is an improvement over the previous meaning. It also does not allow for events of larger than point size. Finally, the use of event as "point on a manifold" is not satisfactory as it is a purely formal object. Manifolds may describe the world, but the world itself is not partially a manifold.

She instead suggests that the fundamental meaning of event in physics and metaphysics ought to be the excitation of a quantum field at a point. These in turn can turn into larger (spatiotemporally) events by juxtaposing many tiny excitations of a field. This may in turn have properties the components do not - i.e., emergent properties. Auyang does not discuss this possibility as she is only concerned with QFT. (If this sounds like turning a mereologically fused collection of point events into a process, this view is correct, but not damaging. I shall discuss the distinction between events and processes as one of the applications of the account developed in section four of chapter four.) I shall also discuss the merits and competitors (e.g. that of Bartels's 1999 [1998]) to Auyang's proposal. I shall also evaluate the possibility of the "emergence" of other kinds of events based on some considerations from chemistry.

This brings us to the other source of scientific relevance. Events in the 'metaphysical sense' (above) occur also in physics. For instance, particles undergo swervings; photons undergo diffractions and reflections; there are oscillations of electric circuits and spring-body systems, and many more. It thus also bears investigating these cases, which can be regarded as halfway between the strictly physics uses of the word event and the ordinary language conception. This is because the events in question are not ones that are part of every day experience. The refraction of photons happens daily, but we are not experientially aware of its mechanism, causes, many of its effects, etc. Thus, they may allow us to discern features of at least certain events that go beyond every day experience. (This feature of many events will play a most important role when I discuss the issue of whether all events are caused.) This implicit scientific use will also provide data for refining our pretheoretic conception beyond ordinary language. I will use these data to refine the account of events as most philosophical discussions on the subject of events have not strayed much into scientific areas.

Section 4 - Division of Labour

We have seen in the previous two sections that understanding events impacts many areas of science and philosophy. This section of the thesis explains the division of labour I shall make use of in the rest of the thesis. Since this work is a study in metaphysics, it bears distinguishing metaphysics from two other areas of philosophy events are relevant in so as to be clear about what I am not doing in the current thesis. This will allow me to make a few positive methodological remarks concerning the "science orientation" of the present work and how it is different from "natural language" approaches in philosophy.

First, it is necessary to distinguish metaphysics from semantics. This must be done in two somewhat distinct ways.

I shall discuss the "natural language analysis" practice that is sometimes popular in philosophy, as well as the role of semantics proper.

Many works on events, e.g., Davidson (1980 [1967a]) announces (pp. 105) that he is concerned with logical form; he (1985, particularly pp. 173-175) and Bennett's (1988, particularly chapter 11) also study the semantic properties of sentences, predicates, etc. having to do with events. It is quite true that one can learn about our ordinary language conception of the **meaning** of "event" and the **grammar** of event terms (and their linguistic interactions with other linguistic features) by studying our habits of language.

The above said, this thesis does take as methodological starting point the analysis of certain kinds of behaviour. It has been something of a tradition in philosophy to do this via linguistic behaviour. Davidson (as we shall see in chapter two) uses a semantic analysis to draw a metaphysical conclusion - that there are such objects as events. There are at least four reasons to suppose that this analysis is not sufficient or is potentially misleading.

The first of these (and the most important one as far as Davidson's analysis is concerned) is that this form of analysis often makes the inference from "x is bound by an (existential) quantifier" to "x exists." This is rather odd: as Chisholm (1970, pp. 15) points out, often one quantifies over times. Chisholm draws the conclusion that this would commit us to thinking that times are objects. Since, however, in science one quantifies over times without thinking times are objects (as there are good reasons to suppose that time is a relation), Chisholm's view is possibly false. But, we can also say what appear to be true statements about objects either commonly accepted as fictional (e.g. characters in Shakespeare's plays) or over objects whose existence (fictional or otherwise) is a matter of contention. We

certainly quantify over mathematical objects as relatively uncontroversial as numbers. Yet, some (e.g. Bunge 1985, pp. 26-40) argue that mathematical objects are fictitious. We have thus seen three possibilities for objects which are quantified over and yet do not exist. First, as in the case of times, we could be quantifying over what is (apparently) actually the degrees of a relation and hence not over objects. Second, as in the case of Shakespeare's characters, we could be quantifying purely fictional objects. For example, we can say (apparently truthfully): "Some of the fools in Shakespeare's plays are called Benvolio", which is normally rendered something like $\exists x(Sx \ \& \ Bx)$). Third, we could also be quantifying over objects whose factual existence is disputable, as in the case of mathematical objects. The argument from quantification is thus weak on these grounds. Note that these all apply to attributes of events (such as their principles of individuation) as well as existence claims. I shall discuss this latter issue further in chapters 2 through 4 as I discuss, evaluate and then posit features of events.

Other reasons to suppose that logical (or natural language) analysis alone is not sufficient for metaphysics are raised by Davidson himself (1980 [1967b], pp. 146) (emphasis added):

"On the score of ontology, too, the study of logical form can carry us only a certain distance. If I am right, we cannot give a satisfactory account of the semantics of certain sentences without recognizing that if any of those sentences are true, there must exist such things [objects in this thesis' terminology - K.D.] as events and actions. Given this much, a study of event sentences will show a great deal about what we assume to be true concerning events. **But deep metaphysical problems will remain as to the nature of these entities. Perhaps we will find a way of reducing events to entities of other kinds, for example sets of points in space-time, or ordered n-tuples of times, physical objects and classes of ordered n-tuples of such. Successful reductions along these lines may, in a honoured tradition, be advertised as showing that there are no such things as events.** As long as the quantifiers and variables remain in the same places, however, the analysis of logical form will stick."

An (ontological) elimination of events, a reduction of them to something else, or some other change in our understanding of them may come out of a further analysis. Davidson is

rightly pointing out that this further analysis need not be - and perhaps cannot be - based merely on the semantic or logical analysis of event sentences.

There is also the possibility, more likely in the cases of identity and individuation than in the case of existence, that our pretheoretic conceptions get the categories and features associated with a concept wrong. This has been pointed out as being the case in other areas of metaphysics, particularly in the philosophy of mind (e.g. Churchland 1995, pp. 6 ff and elsewhere and Damasio 1999, pp. 9 implicitly point out that we talk as if there were things called minds, when it is probably more nearly correct to say that there are processes that "mind".)

Finally, there is the possibility that the semantics of a language will prove rather different from that of English. If semantics "mapped neatly onto" metaphysics, we would then be forced to choose which language reflected the world best (thus requiring us to do what I think is necessary anyway) or we would have to draw a relativist moral. Since we can avoid the relativism by examining events in other ways, we can thus avoid this possibility altogether by limiting the scope of semantics.

I thus restrict the sole use of natural language analysis in the present work to the question of the existence of events. I consider Davidson's argument to this effect more or less satisfactory. However, the more we investigate some possible feature of the world, the more one must be careful not to be misled by purely linguistic considerations. Therefore, in later sections of this thesis, particularly as pertains to the question of individuation, I shall make use of additional methods of analysis. I turn explaining these other methods now.

I propose that analysis of two related kinds of behaviour be used. The first of these is the analysis of scientific language rather than natural language. The other form of

analysis, and the more important one for my purposes is to examine the various practices of science. Scientists do not simply write texts with certain semantic properties. They also perform experiments which (being non-linguistic) have no semantic features and build apparatuses for measuring features of the world. These and other nonlinguistic practices⁵ of scientists can also be used as data for building a philosophical account of some concept or other. Also, although scientists do produce texts, making use of these to discern the metaphysics required cannot be merely a matter of semantics, as the metaphysical principles inherent in scientific research are seldom stated in the writings of scientists. Furthermore, scientists may be wrong about the metaphysics implicit in their work when it comes to stating them in other contexts.

I am presupposing by using this method as stated that the primary scope of semantics is that of linguistic items - languages and their parts. I adopt this view as many philosophers (such as those discussed in Blackburn 1995, pp. 820) and it appears, most linguists (e.g. Ogrady and Dobrovolsky 1996, pp. 233; Pinker 1994, pp. 481) adopt this viewpoint. It might be rejoined, however, that I am taking semantics too narrowly, and thus dismissing methods based on it too quickly on those grounds. If the reader believes that semantics has a larger scope than linguistic objects, this is not a problem for the methodology in this work. After all, the presuppositions of scientists in question would still largely be tacit on this understanding and thus suitable for philosophers to discern by the method I have described. On this conception, the method would still make use of scientists' extralinguistic knowledge and presuppositions - this is all that matters. Further, saying that these other projects and activities "have a semantics" does not argue

⁵ Obviously these non-linguistic practices and their presuppositions can be described and elucidated in language - I shall be doing just that. However, that does not entail that they were couched in language to begin with.

against the need to move beyond natural language analysis. Again, natural language is rooted in common sense (though, of course, its analysis need not be) and common sense can often be common prejudice. Since we have a means (science) to refine, extend and surpass common sense, I do not feel that we should hesitate to investigate its presuppositions too.

Thus, when it comes time to (e.g.) analyze the identity and individuation conditions for events, it is reasonable to investigate the nonlinguistic practice of scientists. Just as in the case of the analysis of natural language, one runs a "by their fruits ye shall know them" analysis. In other words, were it the case that there were no such objects as events, our pretheoretic ways of speaking would be largely false. Moreover, if events did not have identity and individuation criteria thus and so, scientific practice would not work the way it does⁶.

This method (or rather meta-method, as it tells how to construct specific methods) can be summed up as follows (throughout, read "scientific or technological" for scientific, as the method extends to the practice of technology as well):

- 1) Find a case of scientific practice or of scientific findings that *prima facie* exhibits the metaphysical concepts one wants to elucidate. This presupposes that scientific research uses (albeit sometimes tacitly) certain concepts traditionally associated with metaphysics. That this is so I shall not defend in this work.
- 2) Show how the findings presuppose a particular

⁶ I note in passing that this approach is generalizable. To find out about art and aesthetic concepts we need not merely analyze language of art and aesthetics but investigate (say) actions of artists and musicians, etc. I suggest we investigate science for metaphysical hypotheses because both science and metaphysics investigate the world generally, rather than (say) express human subjective experience as is the case in art.

understanding of a metaphysical concept, i.e. would be incomprehensible, blatantly false, or would impede successful research without it.

- 3) Given that the finding is more or less correct, or that the scientific practice in question is fruitful, conclude that there is something correct about the principle presupposed.
- 4) Revise the *prima facie* understanding of the metaphysical concept if necessary.
- 5) Check the understanding of the concept against other scientific situations. Revise, extend, modify or discard the concept as necessary; return to step 1.

Note that this requires a very weak form of scientific realism which I shall also not argue for in this thesis. (A similar argument supporting scientific realism itself can be run. See Bunge 1998, vol I., pp. 330) Also note that the *prima facie* concept may be either one from pretheoretic understanding, or one from previous applications of this or

other metaphysical methods⁷. I call this the "argument from the success of science." I shall illustrate the argument from the success of science by means of an example which also illustrates (by the argument from the success of science) an apparent fact about events⁸. This fact is that events are classed into various levels. The example shall illustrate that one can distinguish between the physical level and the chemical level.

Tobe (1972, pp. 36 ff) uses a radiotracing method which

⁷ It may be objected that this method is fallacious as it appears to be affirming the consequent. This is related to Popper's (1999 [1959], pp. 76 ff) objection to the idea that science deals with truth (and not merely what has not been shown to be false) and the central claim of his falsificationism. The received view in philosophy of science is that inference in science is not always strictly deductive, and functions through, in part, indicators instead. For example, one cannot even solve the basic equations of fluid dynamics in full generality, never mind put them to the test. Nevertheless, it is held that they are more or less true because their consequences are. These consequences are indicators of the truth of the basic statements. How indicators work in science generally, and in particular, the logical form of their statement(s), is off topic for the present work. That this approach does not follow a strict logical rule is regarded as acceptable because the procedure is a heuristic. In particular, supposed nonlogical connections between antecedent and consequent are at work, and so the inference is one "to the best explanation" as Harman (1973) discusses. For a further discussion of this matter as it pertains to scientific research one can consult (for instance) Bunge 1998 (vol. II, pp. 325-403). Therein is found a discussion of the nature of the various forms of inference as found in scientific research in particular. This thesis' "arguments from the success of science" regard scientific success as indicators of the truth of their metaphysical presuppositions in an analogous fashion. Rather than indicating a specific scientific hypothesis these successes instead indicate a general scientific hypothesis - i.e. a metaphysical one.

⁸ It is impossible to illustrate the method without appeal to a specific metaphysical concern. I thus pick one that will be useful later in the present work.

presupposes this distinction. In this example, one investigates whether any chemical events occur in a given case by means of a physical indicator. It thus illustrates that in order to understand events different levels of reality must be understood⁹. I shall show how these different levels are presupposed in understanding the outcome of the experiment, and thus by the argument from the success of science one can then conclude reality (and the events that happen) are multileveled at least in this respect.

First, carbon-14 label some methoxide ($^*CH_3O^-$), and react it with $(C_2H_5)(C_6H_5)PO(OCH_3)$. If the system comes to equilibrium and no radiolabeled $(C_2H_5)(C_6H_5)PO(OCH_3)$ is found, conclude that no chemical events took place.

However, the radioactive decay in the $(C_2H_5)(C_6H_5)PO(O^*CH_3)$ if found, is a purely physical event. This is because it does not (qua decay) involve the formation of any new chemical species¹⁰. On the other hand, it indicates that a chemical reaction (hence a chemical change, hence in turn a chemical event) occurred between the $(C_2H_5)(C_6H_5)PO(OCH_3)$ and the methoxide added by the fact that the radioisotope now appears in the $(C_2H_5)(C_6H_5)PO(OCH_3)$. The methoxide group in this chemical species has changed. Now, if we look at this transformation strictly chemically, $(C_2H_5)(C_6H_5)PO(OCH_3)$ is put

⁹ I use the term "level" as this anticipates the arguments later that establish a hierarchy of sorts. I do not run the full "levels" argument here as it is (a) not needed (b) off topic and (c) too long. Strictly speaking, then, the argument only shows the need for two kinds of events; later ones show that in order to have kinds (understood this way) one needs the hierarchy in question.

¹⁰ Of course, it may cause a reaction of the $(C_2H_5)(C_6H_5)PO(OCH_3)$, but (apparently) causes need not be at the same level as their effects. Besides, the radiolabeling acts as an indicator of earlier chemical changes, hence events, not any ones that occur after the decay.

into the reaction, and it is taken out again¹¹. We would conclude no change had occurred, if it were not for our physical indicator of the chemical process. Hence, the argument from the success of science suggests that this two (and hence possibly multi-) level approach is fruitful. Science would have gone wrong without it. Of course, to conclude that reality (and events) come in more than just these two levels we would need further investigations. Note, however, that this argument presupposes that there are distinctly chemical properties. (For this point, also argued for using the "argument from the success of science" and other metamethodological considerations, see Bunge [1982].)

In other words, I do not reject the "natural language" analysis approach to metaphysics that Davidson begins with, but merely regard it as insufficient (as Davidson himself seems to.)

A final way to see the distinction between metaphysics and semantics concerns what Asher (1993) after Emmon Bach calls the natural language metaphysics of abstract objects. He explains why going beyond our grammatical conceptions of these objects (such as events) is important as follows (1993, p. 2), italics in original, bold added:

"Natural language metaphysics distinguishes many sorts of objects. But often it fails to provide **clear identity conditions** or a **full analysis**. Natural language metaphysics is thus at best a *partial* theory of abstract objects. A second level of analysis maps the ontology of natural language metaphysics onto a sparser domain - a more systematic realm of abstract objects that are fully analyzed. This second level reflects the commitments of *real* metaphysics."

I take myself as doing *real* metaphysics. One need not adopt the position that events are abstract (as we shall see later, I do not) to adopt Asher's two-leveled metaphysics.

¹¹ A reminder: different isotopes of a given element are generally speaking chemically equivalent, so a radiolabeled species is chemically equivalent to its non-radiolabeled counterpart. A purely chemical indicator thus would not indicate that the appropriate event had occurred.

Once we have seen what "natural language metaphysics," a certain species of discourse involves (in this thesis, Davidson's work on action sentences), one can then extract the conditions of identity and individuation for events from them and begin to apply the method from the success of science, above. From then on, the semantics proper of event sentences (in our case) becomes irrelevant; we can "kick away the ladder." I note in passing that this is what Davidson himself seems to be doing in some of his later work, and that Kim's work (which we shall also meet as a critic of Davidson's and as a means to refine Davidson's work) has already done this. There is very little reference to language or semantics *per se* within Kim's (1993) work on events.

I have now discussed the relationships between semantics and metaphysics as it pertains to the present work as well as discussed some aspects of methodology. So, next, it is necessary for me to distinguish metaphysics from epistemology and complete the discussion of the methodology of this thesis.

As has been remarked previously, this work is centered around the notion of principles of individuation for events. After Lombard (1995, pp. 239-241), I distinguish two meanings of individuation, epistemological and metaphysical. Metaphysical individuation concerns how particulars of a given kind are distinct from each other and how a given kind of particular is different from other kinds. I.e., in the case of the present work, I am attempting to determine how a given event is a particular (and how one argues for the view that events are particulars), and further how events (in general) are not like other kinds of objects. By contrast, epistemological individuation concerns how a knower comes to recognize a given object as distinct from others.

I am not concerned with epistemological individuation in this work except so far as: if we think we can individuate

events in this sense, and one's ontological criteria makes epistemological individuation impossible, the tension that results must be dealt with. I will examine this issue further during the discussion of Lombard in chapter three, section two. Since this work takes Davidson's analysis as a starting point, this epistemological burden will be shared with him. Some of the positive account of my own in chapter four will examine how his account can be added to without losing its epistemic virtues.

On the other hand, as may be inferred from section three of this chapter and earlier remarks in this section, I do not see the need for any direct division of labour between science and metaphysics¹². I thus must add to my limited ordinary language analysis (discussed above in the semantics section) a scientific analysis of the sort previously discussed. This method presupposes no dividing line between science and metaphysics. I shall not argue the point, but this thesis in general (not just in the use of its methods) takes a "grey box scientific realism" for granted. This is the assumption that the large scale structure of science does contain a body of truths (partial and provisional in most individual cases), but that it is sometimes difficult to tell which propositions to accept as being roughly truthful. It is thus important to realize that it is the "spirit" behind my scientific examples, not their details which matters - despite this, I do use scientific examples because they have often been studied in greater depth than those from every day life.

In addition, I adopt the background of science for what Kant called regulative concepts; I thus adopt the scientific method in broad outlines. The presuppositions of scientific method will be used to develop my understanding of events as well (see chapter four, sections one through four). This is a specific case of the argument from the

¹² After Bunge (1977, pp. 4 ff.) I hold that metaphysics is a general science and that the "special" sciences (physics through history) are, so to speak, specific metaphysics.

success of science discussed above.

We have seen how problems pertaining to events fit into our understanding of metaphysics and science. Now I must turn to examining Davidson's conception of events, starting with his "existence proof."

Chapter 2 - Davidson's Account of Events

This chapter consists of two sections. The first of these explains the origins of Davidson's account of events through a discussion of the views of Kenny (1963). Davidson's response to Kenny provides what might be called an "existence proof" for events.

The second section examines three other metaphysical issues about events that arise from Davidson's work, and surveys his views on these by examining his work chronologically. Davidson discusses whether events are particulars or not, whether events have properties of their own, and what a correct individuation principle for events would consist of. This latter point is the central issue of the present thesis. Exploring in this chapter how this principle develops and gets modified in Davidson's work leads to a defense of part of his account against criticisms in chapter three. Finally, this chapter also develops Davidson's account of events as a starting point of my own principle of individuation proposed in chapter four.

Section 1 - Davidson and Kenny

Davidson begins his exploration of events in his "The Logical Form of Action Sentences" (1980 [1967a].) The stated goal of this paper is to give an account of the logical and grammatical role of the parts of sentences about action in order that intuitively correct entailments obtain (pp. 105). Despite this logical and semantical focus, we herein find four main theses about the metaphysics of events. I shall introduce one in this section by means of showing how it is a natural inference from Davidson's semantics, and return to it in section two. The remaining three shall be the subject of the second section in this chapter.

This first issue we shall examine is the view that there are in fact events. This consists of two parts. The first

part is the evidence from sentences expressing actions (pp. 107-108). Davidson tells us (pp. 108):

"Much of our talk of action suggests the same idea: that there are such things as actions [...]"

That is to say, Davidson suggests that there are such objects as actions. This approach is compared to that of Austin (pp. 109):

"[...] Austin's discussion of excuses illustrates over and over the fact that our common talk and reasoning is most naturally analyzed by supposing there are such entities."

But, what sort of objects (entities, in the above) are actions? Davidson's answer: they are one kind of events (pp. 111).

Davidson is interested in determining when actions are the same to determine coreferentiality of sentences involving action words (pp. 112).

For a brief look at how Davidson attempts to obtain a metaphysical hypothesis from semantic considerations based on the above problem of coreferentiality, let me examine a sample sentence that he analyzes: "Shem kicked Shaun." He renders this as: $(\exists x)(\text{Kicked}(\text{Shem}, \text{Shaun}, x))$. Here x ranges over a set of events, and thus can be rerendered in English as: "There is an event x such that x is a kicking of Shaun by Shem." I emphasize this to indicate that Davidson's analysis is "deep"; it does not merely rely on the superficial features of sentences. Specifically, this case indicates how Davidson does not simply use meanings of words to obtain his metaphysics. Conceivably one could just look at which words intuitively were those of event words (for instance, "kicking") and thus conclude our language is such that there appear to be events. But, Davidson goes a step further, showing that the deep structure of English makes reference to events. Thus, according to Davidson, not only does our vocabulary suggest events but our syntax and deep grammar do so as well.

This analysis provides Davidson with what he wanted to obtain, namely, an analysis that allows one to infer from "Shem kicked Shaun with a booted foot." to "Shem kicked Shaun." Let us see how Davidson obtains this analysis, but in order to this I must first digress briefly and expound Kenny's views on action sentences to show how Davidson's logico-semantic procedure is novel and has interesting features that earlier elucidations did not have.

Kenny's account of action sentences (Kenny 1963, pp. 152-170) is concerned with clarifying the notion of an action through analysis of the verbs of action. This project has three stages. First, he distinguishes between words of action and words of relation. This logical distinction is related to distinction between the subjects and objects of transitive verbs. Second, he distinguishes verbs of various sorts, singling out one particular sort as most relevant to referring to voluntary action. Finally, he distinguishes between various sorts of (grammatical) object.

Kenny's concern in the chapter I shall focus on is transitive verbs that can answer questions of the form "What did A do?" This is the first of the three stages I just mentioned, and the one that leads most directly into Davidson's project.

To support his claim that words of action and words of relation are not of the same sort, Kenny provides four arguments. The first of these is that if "Brutus killed Caesar" makes use of a relation word (and not a *sui generis* action word), it is difficult to understand how this permits the deduction of "Caesar was killed." Kenny points out that one might be tempted to say that "Caesar was killed" is elliptical for "Caesar was killed by someone."; in which case the pattern of inference would go as follows:

Kcb

∃xKcx

However, Kenny says that appealing to ellipticality here does
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not work, as he claims that we can (using this reasoning) say that "Plato is older than Aristotle" is elliptical because it may have "by forty years" attached to it, and that there is no limit to the amount of further information that can be added to any given sentence by further specification. Kenny seems to think that the above considerations show that the intuitively correct entailments are not logical but semantic in character.

In the second of the four arguments, Kenny points out the second difference between (words of) action and (words of) relation. As he puts it (1963, pp. 159):

"A sentence reporting an action not only can be shorn of one of its terms without making nonsense; it can also have further terms added to it in various ways."

Kenny suggests that "Brutus killed Caesar in Pompey's theatre with a knife" does not express a tetradic relation between Brutus, Caesar, Pompey's theatre and a knife. He claims that this if this were so, it is a "chameleon-like" (his words) relation which is now dyadic, now triadic, etc., or it is a quite different relation than the one which appears in "Brutus killed Caesar," which makes being capable of inferring the shorter sentence from the longer one difficult to understand.

One might be tempted to appeal to ellipticality again. However, Kenny claims this will not work. He supports this by reminding the reader of the Latin tag that gives a partial list of questions that can be asked about any particular action. And, so because of these indefinite degrees of specification that (he claims) are possible, Kenny considers the suggestion that we make use of an operator rather than predicates to modify descriptions of actions. For instance, in considering "Brutus killed Caesar with a knife," he reports Prior as saying that we should treat "it was with a knife that" as an operator applying to the sentence "Brutus killed Caesar." Kenny rejects this approach as there will be an indefinite number of these non-truth-functional operators

and so the move would seem *ad hoc*.

Kenny's third way of distinguishing action sentences from relational ones consists of the ways in which the two putative kinds of sentences may be false. By this he means (1963, pp. 163), italics in original:

"A sentence may be false in more than one way, in this sense, if and only if more than one state of affairs which would make it false may be described *merely by the use of terms occurring in the sentence itself* along with quantifiers, variables and the negative operator."

He supports this contention by comparing "Lear gave away his kingdom to Cordelia." to "London is between New York and Moscow." There are five sufficient but not necessary ways in which the former sentence could be true. These are (1963, pp. 163):

- "(1) Lear did not give his kingdom to anyone
- (2) It was not to Cordelia that Lear gave his kingdom
- (3) Lear did not give anything to Cordelia
- (4) It was not his kingdom that Lear gave to Cordelia
- (5) Lear did not give anything to anyone."

These are to be compared with the following parallel set of sentences (1963, pp. 164):

- "(i) London is not between New York and anywhere.
- (ii) It is not Moscow that London is between New York and.
- (iii) London is not between anywhere and Moscow.
- (iv) It is not New York that London is between and Moscow.
- (v) London is not between anywhere and anywhere."

Kenny suggests that (i)-(v) are odd in a way in which (1)-(5) are not, claiming that (i), (iii) and (v) are false *a priori* and that (ii) and (iv) have no clear sense.

I next turn to Kenny's fourth reason for distinguishing between action (words) and relation (words). He claims that in action words (only), a property of "one way meaningfulness" sometimes exists. To reverse an irreversible verb is to make a category mistake. For instance, "Raven is taller than Robin" makes as much sense as "Robin is taller than Raven" although the latter happens to be false. On the

other hand, Kenny says, "Robin ate a vegetable burger" is meaningful, but "A vegetable burger ate Robin" involves a category mistake.

Kenny does not develop any positive account of variable polyadicity or other logico-semantic features of action verbs which would be needed in order to solve the above problems.

Instead, he claims merely to have distinguished between words of relation and verbs of action (1963, pp. 169-170) albeit in a ragged and somewhat imprecise way. He puts this himself as follows:

"In this chapter I have tried to draw from various points of view a broad distinction between [words of - K.D.] actions and [words of] relations. The distinction is not a sharp one, but has ragged edges: predicates which by some of the criteria suggested would count as actions would by others count as relations."

(Note that throughout Kenny runs roughshod over the distinction between actions and words referring to those actions.)

Davidson's first paper on events (1980 [1967a]) can hence be seen as an attempt to take Kenny's analysis of what action sentences are (presumably) not like and build a positive account and 'bring them back into the logical fold.' (As I noted above, Kenny thinks that entailments between sentences with action words occur at the semantic level.) I shall turn to this now.

A traditional solution involving rendering each predicate with its own polyadicity is rejected by Davidson, following Kenny (pp. 106-108). This solution is rejected as it does not allow certain kinds of inferences that intuitively obtain. For instance, we cannot infer from a two place predicate to a three place one on the same subject. "I flew my spaceship" [represented traditionally as "Flew α (I,my spaceship)"] is not entailed by "I flew my spaceship to Vulcan" [represented traditionally as "Flew β (I,my

spaceship, Vulcan)] as "Flew α " and "Flew β " are not the same predicate (the former is two place, the second three - we even have to indicate that they are distinct predicates, as I did with the subscripts). To represent both as "Flew" would be to commit a fallacy of equivocation. In other words, in conventional predicate logic, there is no inference $F\beta(I,S,V) \therefore F\alpha(I,S)$ or $F\alpha(I,S) \therefore F\beta(I,S,V)$, never mind any inference from $F(I,S,V)$ to $F(I,S)$. The latter is syntactically heterogeneous and hence illformed in standard predicate logic. In general, there is no (known) theory of (logical) entailments between variably polyadic predicates, so this approach does not do what Davidson wants.

Another possibility, which Davidson also rejects, would be to use a three place predicate in both cases and an existential quantifier: " $(\exists x)(\text{Flew}(I, \text{my spaceship}, x))$." (Roughly: I flew my spaceship somewhere.) However, this does not work as a solution to Davidson's problem, as conceivably one could increase the polyadicity of the predicate without limit as Kenny already pointed out (as noted above.)

Instead, Davidson proposes two distinct semantic theses. First, that certain verbs (so-called "event verbs") contain a place for singular terms or variables that they do not appear to contain. Second, that we can attach other modifiers with conjunctive clauses as follows, and make reference to a new object that all these modifiers are about. For example, "I flew my ship to the evening star" becomes: " $(\exists x)(\text{Flew}(I, \text{my spaceship}, x) \ \& \ \text{To}(\text{The Evening Star}, x))$ " - in other words: there was a(n event of) flying of me to the evening star in my spaceship. From this we can, for instance, allow the inference from "I flew my ship to the evening star" to "I flew my ship." by the rule of simplification. This approach also allows the use of the rule of substitution. We can infer from $(\exists x)(\text{Flew}(I, \text{my spaceship}, x) \ \& \ \text{To}(\text{The Evening Star}, x))$ and "The Morning Star" = "The Evening Star" to $(\exists x)(\text{Flew}(I, \text{my spaceship}, x))$

& To(The Morning Star,x)), which recaptures the intuitive entailment between "I flew to the evening star, the morning star is identical to the evening star" and "I flew to the morning star."

Similar analyses would allow us to perform the inference in our original example of Shem, Shaun, and Shem's booted foot. $(\exists x)(\text{Kicked}(\text{Shem}, \text{Shaun}, x) \ \& \ \text{With}(\text{booted foot}, x))$ could be one such formalization of "Shem kicked Shaun with a booted foot" which is rendered "There was an event such that it was a kicking of Shaun by Shem and it was with a booted foot." We can thus understand the inference:

Shem kicked Shaun with a booted foot.

Shem kicked Shaun.

as involving an application of the logical rule of simplification (and a distribution of the existential quantifier):

$\exists x((\text{Kicked}(\text{Shem}, \text{Shaun}, x)) \ \& \ (\text{With}(\text{Booted foot}, x)))$

 $\exists x(\text{Kicked}(\text{Shem}, \text{Shaun}, x))$

This restores logical entailment in situations where Kenny thought none was possible. Furthermore, this formalization allows recapturing the fact that ordinary discourse requires us to apply many predicates to event verbs (pp. 120). Kenny's problem of variable polyadicity does not occur. Each event verb (action verb) has a fixed polyadicity, and can be conjoined with descriptions and modifiers that also make reference to that particular event.

I shall call the approach of fixing polyadicity and conjoining indefinite numbers of modifiers the "modification approach." Davidson has thus obtained one possible solution to his problem of giving the logical form

of action sentences. He does not show it is the only such possibility, nor even that it is the best of all other alternatives¹³, merely that some other alternatives do not have the required features and that his does. I show how Davidson does this by means of his responses to representative criticism.

One possible weakness of the modification approach as it stands was pointed out by Wedeking (2001a). He suggests that Davidson's approach leads us to the view that there is perhaps no canonical description for an event. Each event can be referred to in any number of ways. This is not so much an objection to Davidson's account, but a curious consequence of it, one that may or may not be favourable depending on one's other philosophical commitments.

Castañeda's (1967) objection to Davidson concerning the inference from sentences containing transitive verbs to their intransitive counterparts is similar. This also concerns the minimal number of modifiers an event word can have and the relationship between the modifiers and the original word in the logically regimented reconstruction. For instance, "kick" is (sometimes) regarded by Davidson as a two place event verb (i.e., relation) to which we can apply an indefinite number of conjoined modifiers.

The worry common to both the above concerns can be put as follows: how does one allow the inference from:

¹³ Conceivably one could develop an alternative logic that allows predicates of varying polyadicity and logical relations between them (e.g. entailment) but no one has ever done such a thing. Reasoning about functions and relations of intrinsically variable polyadicity is common in computer science though their use is fundamentally different than it is in semantics or standard logics. On this approach, which makes use of a modified lambda calculus, it would be easy to preserve the virtues of entailment Davidson wants. However, it would be hard to capture the virtues of allowing an indefinite number of modifiers with a common event place as Davidson's approach does.

Shem kicked Shaun.

to

Shem kicked.

while keeping Davidson's analysis intact?

Two possibilities come to mind. Most recently Davidson (1980, pp. 126) (apparently) thinks¹⁴ that this inference is licensed by writing the inference as follows:

$$\exists x(\text{Kicking}(x) \ \& \ \text{Of}(\text{Shaun},x) \ \& \ \text{By}(\text{Shem},x))$$

$$\exists x(\text{Kicking}(x) \ \& \ \text{By}(\text{Shem},x))$$

and using the rules of distribution, simplification and addition. This has the (perhaps) curious consequence that one can infer from "Shem kicked Shaun" to "Something was done by Shem"¹⁵ This is formalized as follows:

$$\exists x(\text{Kicking}(x) \ \& \ \text{Of}(\text{Shaun},x) \ \& \ \text{By}(\text{Shem},x))$$

$$\exists x(\text{By}(\text{Shem},x))$$

A second possibility to explore would be to note that to move between the two senses of "kick" I have just mentioned

¹⁴ There is a difficulty here. Earlier Davidson (1980 [1967b], pp. 125) had thought that semantic entailment (the second possibility I canvass below) was the solution to this problem. The footnote on pp. 126 (written in 1980) says that Davidson changed his mind, and now prefers a logical solution. He does not state what this logical solution is to be. After Wedeking (2001b)'s suggestions, I hold this possibility as the likely one.

¹⁵ Since the logical form of this sentence does not preserve the semantic feature that the event in question was an action (as one would likely expect) one must avoid reading this as involving the usual features of an action. It is compatible with Shem having swerved on a roller coaster or something along those lines, which is not normally considered an action. Not all events an agent undergoes are actions.

would involve an equivocation. I.e., that the two place "kick" (as in Shem kicked Shaun) and the one place "kick" (as in Shem kicked), are actually two different verbs and so the entailment, if there is one, is semantic. Davidson favours the former solution, and so do I as it allows more logical entailments of the kind his 1980 (1967a) shows as possible.

This solution does suggest a semantic and epistemological motivation for the question of event individuation as follows. As noted above, any number of phrases can refer to putatively the same event, even such apparently odd ones as "something was done by Shem." Since none of these phrases involve what might be called canonical descriptions of an event, one cannot hypothesize the essential characteristics of an event from the structure or features of sentences referring to it. Hence the conceivable general approach of developing a principle of individuation from the logical structure of event sentences seems impossible.

For example, consider "something was done by Shem" again: it seems implausible to suggest that this phrase captures many of the features of the event it refers to. It certainly does not capture all of them, as it does not even make reference to the genus (action, etc.) of event it refers to, never mind its species (e.g., kicking, swerving, dying). So Davidson must find another way to approach the question of individuation than through the form of event sentences. I shall explore Davidson's own solutions to the individuation problem in section two below.

Since the focus of the current work is metaphysics, not semantics, I need not tarry longer on the semantics of event sentences here. There is, however, the possibility that the semantics picks out the wrong objects in the world and thus does not work to get Davidson's metaphysics off the ground. I shall address part of this concern below, and more in chapter three when I consider the possibility that Davidson's analysis works only in English. I now turn to

the metaphysics involved in Davidson's understanding of events, centered around the question of their individuation.

Section 2 - Davidson's Metaphysics of Events

As mentioned above, there are more directly metaphysical questions lurking in Davidson's semantics. I shall now explore how these questions originate and develop throughout Davidson's work on events, and show how they involve the central questions of the current thesis. I shall survey chronologically how Davidson explores these problems.

To begin, Davidson's use of semantics (1980 [1967a]; see section one above for discussion) rests upon an interesting feature about human interaction and language, which in turn rests upon a metaphysical assumption. This linguistic feature consists in the fact that we can ask questions about the features of the objects that are bound within the scope of the existential quantifiers used in his analysis. The fact that we can do so truthfully (again, presupposing a realist theory of reference) requires that there are such objects with their features. Let us look first at this ontological commitment to events and what it involves, and then look at the modification approach; the two are independent as one could conceivably take a realist approach to one and not the other.

Davidson's understanding of the quantifiers and hence (putative) ontological commitment is due to Quine (1999 [1948], pp. 9), who explained it as follows:

"[...] a theory is committed to those and only those entities to which the bound variables of the theory must be capable of referring in order that the affirmations made in the theory be true."

In this sense, Davidson's semantic theory sketched in section one forms a sort of "existence proof" for events. Without events, the statements of the kind discussed above in section one (e.g. "there was a kicking of Shem by

Shaun") would not be capable of being literally true or false. But, as noted above (in chapter one) a problem of the understanding of the existential quantifier lurks here due to the fact that we can quantify over fictitious objects. I agree, however, that our language does suggest there are objects which we call "events." Bunge (1999a, pp. 90) introduces a real existence predicate in order to express ontological commitment without the use of the quantifiers for this purpose. Using this, I suggest we can render "there was a kicking of Shaun by Shem" as:

$$\exists x(\text{Kicking}(x) \ \& \ \text{Of}(\text{Shaun},x) \ \& \ \text{By}(\text{Shem},x) \ \& \ E_r(x))$$

where E_r is the real existence predicate¹⁶. This is to be contrasted with (say) a purely mathematical statement such as "Some number is the successor of 0," which becomes:

$$\exists x(x = 0')$$

which does not involve the existence predicate. Alternatively, since one might think mathematical objects might have conceptual existence relative to a system of constructs:

$$\exists x(x = 0' \ \& \ E_n(x))$$

would do to indicate that there is a successor of zero in the context of number theory. Since this is not the place to do philosophy of logic, I shall assume for the rest of this thesis that we can rewrite Davidson's semantics so real existence is "committed to" but without the dubious usage of the existential quantifier to that end, taking the

¹⁶ The use of this predicate presupposes we can more or less correctly postulate a characteristic function for a set containing the objects in question. Events are understood as dependent on things (how this is to work is spelled out later in Davidson's work when he discusses causation) in ordinary language, and thus a first approximation to the characteristic function makes use of any characteristic function for the set of things one cares to use (e.g. "possesses energy").

above as an illustration how.

The Davidson-like analysis that I have introduced above provides evidence for the existence by showing how events are committed to in language. This raises the question of how event words and so forth work linguistically and raises a problem of how modifiers concerning events work. Davidson suggests (pp. 116-7):

"The problem is solved in the natural way, by introducing events as entities about which an indefinite number of things can be said."

As we have seen, this allows us to conjoin as many event predicates within the scope of the existential quantifier whose variable is an event variable. For instance:

$(\exists x)(\text{Flew}(I, \text{my spaceship}, x) \ \& \ \text{To}(\text{The Morning Star}, x) \ \& \ \text{Slowly}(x))$ can be a modification of the earlier
 $(\exists x)(\text{Flew}(I, \text{my spaceship}, x) \ \& \ \text{To}(\text{The Morning Star}, x)).$

Metaphysically, however, there is a question of how these predicates should be interpreted (i.e. how they relate to properties). This issue is not explained by Davidson except by way of his remark that this semantic approach to event words parallels that of thing words. This suggests that Davidson is committed to a view where events possess their own properties; I shall deal with this later (particularly in the discussion of Kim in chapter three) as Davidson does not consider the issue much here. Note that this answers Wedeking's (2001b) and Castañeda's (1967) worries, discussed above in section one. There simply is no canonical event-referring structure in language, as is also the case with thing words. In this sense "modification approach" is a bit of a misnomer, as what was first apparently modifying an event word (such as "kicking" being modified by an "of" locution) can now stand on its own. To see that none of the event predicates are the canonical description of a given event, proceed as follows. As example, consider again "Shem kicked Shaun." This appears to give pride of place to "kicked." As we have seen, this can be rendered as (according to Davidson):

$\exists x(\text{Kicking}(x) \ \& \ \text{Of}(\text{Shaun},x) \ \& \ \text{By}(\text{Shem},x))$

But by commutativity of the conjunction operator,

$\exists x(\text{Of}(\text{Shaun},x) \ \& \ \text{By}(\text{Shem},x) \ \& \ \text{Kicking}(x))$

is just as legitimate a rendering. It thus cannot be said that under Davidson's account what appears to be the pretheoretic predicate of importance (kicking) remains so in the analyzed form. This leads us straight into the individuation question, as I noted earlier (towards the end of, section one, above.)

Finally in this paper we find Davidson's first considerations of principles of individuation. For instance, Davidson considers a proposal of von Wright (1967a, pp. 113) that events can be individuated by representing them as an ordered pair <initial state, final state>. Davidson rejects this proposal as it does not say enough about the details of the event. He writes:

"If I walk from San Francisco to Pittsburgh, for example, my initial state is that I am in San Francisco, and my terminal state is that I am in Pittsburgh, but the same is more pleasantly true if I fly."

In other words, many different events can be represented using the same pair <initial state, final state>. Not only does Davidson reject von Wright's proposal as it does not detail the attributes of an event, it in turn fails in cases where the initial state is the same as the final state; on his proposal we would have no way of distinguishing (to use Davidson's example) "he circled the field" from something like a null event, or an interval where no relevant event occurred. It is also, says Davidson, difficult to indicate the starting state involved in the events referred to in sentences like "I flirted with Raven." (This latter point of Davidson's is merely an epistemic matter, though - perhaps we do not always refer to the essential characteristics of events. I have remarked this seems likely from Davidson's own analysis of event

sentences.) As noted in chapter one, this question of the principle of individuation for events is the central problem of the current thesis.

Next, we must next examine Davidson's replies to the commentators on 1980 (1967a) to extract the final piece of metaphysics in his early work. He agrees with Lemmon's (1967) suggestion that events have to take place simultaneously in order to be identical; other than that he does not know. Davidson doubted that spatial location can be used as part of a criterion, running the following argument (1967b, pp. 124-125):

"[...] if an event is a change in a certain object, then the event occupies at least the zone occupied by the object during the time the event takes place. But, if one object is part of another, a change in the first is a change in the second. Since an object is part of the universe, it follows that every event that is a change in an object takes place everywhere (throughout the universe)."

Davidson believed the above argument to be faulty, but at this stage did not see how to resolve it. He also seemed skeptical that spatiotemporal location can individuate events for another reason: it appears that two or more could occur at the same place; for instance, I could walk to school with Audrey and catch cold simultaneously. In this case, a walking and a cold-catching (or a disease-acquiring) occur at the same time and place. This example does not of course show that time and place are unnecessary as components of a principle of individuation, merely that they are insufficient.

To close the analysis of this paper of Davidson's, it is important to realize that despite an explicit avowal of his (pp. 124) that at this stage that he did not know how to answer questions of identity for events in general, he in fact was capable of doing so at the time of the paper, in at least some specific cases (pp. 109):

"But what is the relation between my pointing the gun and pulling the trigger, and my shooting the victim? The natural and, I think, correct answer is that the relation is that of identity."

The above passage thus raises the question: what are Davidson's grounds for claiming this identity? These are not made explicit in the current paper. However, the criterion of cause and effect that he adopts in his next paper (1980 [1969]) can be seen here in embryonic form. He appeals to nothing outside the consequences of the action and includes no appeal to the properties or the spatiotemporal location of an event. He does use the notion of simultaneous occurrence, but as we have seen that clearly is not sufficient for a principle of individuation.

We now turn to the next of Davidson's papers (1980 [1969]) - this one explicitly related to the current work's central concern: the correct principle of individuation for events. He suggests that instead of worrying about when apparently two events are one we should instead determine truth conditions for sentences of the form "a = b," where a and b range over events (pp. 163).

Davidson opens the discussion in this paper by rehearsing his motivations for believing that there are events (see above and chapter 1.) These are, to recap: first, the notion of event figures prominently in the philosophy of action; second, events figure prominently in many accounts of explanation in epistemology; third, issues over the identity of events fuel debates concerning the various 'identity theories' of mind; fourth, in semantics certain sentences cannot be easily analyzed as to their meaning unless there are such objects as falls, strollings and so forth (Davidson 1980 [1969], pp. 164 ff.). The latter is the most important of the motivations for my purposes; we have seen how it is used in the semantic analysis of action sentences in the discussion of his previous paper in section one of this chapter.

Let us look at Davidson's arguments against those who would resist these four motivations (pp. 165). Davidson's reasons do not rely on one adopting any particular positions in any of these debates, so long as one finds the debate

intelligible. He puts this as follows:

"The reasons just canvassed for accepting an explicit ontology of events rest upon the assumption that one or another currently accepted or debated philosophical position or doctrine is intelligible when taken at face value; so it remains possible to resist the conclusion by rejecting the relevant doctrines as intelligible, or by attempting to reinterpret them without appeal to events."

There are two key features of the above, the first part of Davidson's explicit defense of an ontology including events. In his 1980 (1967a), Davidson concludes that such an ontology is needed but does not defend or develop its features much beyond postulating the existence of events. As noted above, the first feature is that one need not adopt any of the positions he claims require events (e.g. the mind-brain identity thesis). One must merely find the position intelligible - or, more specifically, discussable and debatable¹⁷. Second, Davidson suggests that the required event ontology is an ontology of "least resistance"; to avoid such objects in one's ontology one has to create a reinterpretation of certain locutions. Needless to say, Davidson does not find this latter prospect terribly promising. Davidson refers the reader to other essays to show what the critic who would deny events must reinterpret.

I shall thus put the rest of "The Individuation of Events" on hold until we have examined one possible area where reinterpretation would be needed. In his "Causal Relations" (1980 [1967c]) we find one such case. Since causation will later play an important role in Davidson's account, this article bears examining in this light as well.

Davidson again obtains his evidence, this time concerning how events are at least some of the relata of the causal relation, from linguistic and semantic considerations. He asks us (pp. 153) to consider the following sentence (*italics in original*): "Jack fell down, *which caused it to*

¹⁷ Davidson perhaps would endorse a Enrico Fermi like remark here: without their being events, these positions are "not even wrong."

be the case that Jack broke his crown."¹⁸ By analogy with a sentence involving times, Davidson suggests (pp. 154) that a correct analysis of the previously quoted sentence is "There exist events *e* and *e'* such that *e* is a falling down of Jack, *e'* is a breaking of his crown by Jack, and *e* caused *e'*." This reading of the sentence is committed to events in the same fashion that "Robin dried herself with a tissue" is committed to tissues, since we can write this sentence using appropriate quantifiers and existence predicate. This shows (says Davidson) that we cannot account for causation and changes (such as that which happens to Jack's crown) without appealing to events. Note that this argument to the effect that events are related of the causal relation uses Davidsonian semantics of the sort I have introduced previously.

Having dealt with Davidson's arguments against those who would do without events, I shall return to his arguments against rival views of events in the original paper (1980 [1969]). This discussion centers around two of the framing metaphysical issues of the present chapter. These are the view that events are concrete particulars, and again, the question of individuation.

On these subjects Davidson discusses the views of Strawson (1959). Davidson takes up two issues that Strawson raises about events, agreeing on one and disagreeing on another. The first issue (pp. 173) is that when describing events one need not refer to the substance involved (e.g.: "that shriek"). This is not really surprising as similar locutions exist with thing words ("that thing!" even works). Davidson and Strawson agree on this point.

But, as Davidson relates, Strawson also suggests that events are conceptually dependent on things ("substances") (pp. 174) but not conversely. Davidson construes Strawson as inferring this from the fact that we can rewrite

¹⁸ Note that this in turn is a more exact statement of the more natural sentence "Jack fell down and broke his crown."

sentences apparently making reference to events without their event terms. For instance (to use the example Davidson discusses), we can rewrite "There was an event that was the birth of this animal" as "This animal was born."

Davidson points out that this is too hasty. It seems odd to say that there are two semantically equivalent propositions with different implicit ontologies. Instead, Davidson suggests that events and things are both particulars (for instance, that "John struck the blow" is about a blow and about John), and neither is conceptually prior to the other. Davidson suggests this by pointing out that we often identify things by the events they have undergone (pp. 175):

"Thus if we track down the author of *Waverley* or the father of Annette, it is by identifying an event, of writing or of fathering. Neither the category of substance nor the category of change is conceivable apart from the other."

I note that Davidson does not talk much about ontology in his discussion of Strawson. Davidson suggests that we cannot conceive of events independently of substances and their changes and conversely, but that this does not by itself tell us anything about the ontological priorities (if any) involved. Nor does it directly answer the question about principles of individuation. Davidson thinks (pp. 173) that substances individuate events, but this does not give precise necessary conditions, merely instead "identical substances, therefore, identical events" is one of several sufficient conditions. Strawson's proposals on our central subject are thus rejected by Davidson.

After discussing Strawson, Davidson then examines spatiotemporal features as a possibility for a principle of event individuation. He rejects spatial criteria with the problem that a spatial location would make all events one, as they would all involve change in the universe as a whole. This is much the argument he presented earlier against Lemmon (see above). The argument works as follows.

Given that an event in a given part of a thing seems to be an event that the whole thing undergoes (for instance: if my arm undergoes a twitching, it seems fair to say that I undergo a twitching), and that the universe is the mereological sum of all things, it thus appears that any event takes place in the entire universe. Davidson does not see how to prevent this unfortunate outcome and thus rejects spatial location to individuate and identify events.

He also presents a paradox to show how temporal location as part of a criterion may appear to have strange consequences (pp. 177). This paradox is as follows:

"Suppose I pour poison in the water tank of a spaceship while it stands on earth. My purpose is to kill the space traveler, and I succeed: when he reaches Mars he takes a drink and dies. Two events are easy to distinguish: my pouring of the poison and the death of the traveler. One precedes the other and causes it, but where does the event of my killing the traveler come in? The most usual answer is that my killing the traveler is identical with my pouring the poison. In that case, the killing is over when the pouring is. We are driven to the conclusion that I have killed the traveler long before he dies."

As it happens, there are reasons to suppose a killing is a distinct from a dying - I find it plausible to say that a killing causes a dying. After all, it seems plausible (using Davidson's criterion from later on) that a dying causes (say) a stink to waft through a room, etc. whereas a killing does not. Davidson seems to agree; after all he says the above paradox is only apparent, immediately following the previous passage with (pp. 177):

"The conclusion to which we are driven is, I think, true, so coping with the paradox should take the form of reconciling us to the conclusion."

I shall not commit much to any views on this subject here - I shall return to it later. However, Davidson points out that some of the paradoxical character is due to our lack of knowledge in certain areas. He says that these fit primarily into three categories. We can recognize a pouring of poison without knowing that it is a killing. This is an

example of being ignorant of certain aspects or properties of an event. Second, if there is a long time between a cause and its effects, the more likely we are to say that it is not the cause involved. Finally, we also can mistake the final state involved in an event for one of its effects. These considerations about the time of an event are not as important as the last consideration concerning spatiotemporal location Davidson makes in this work.

This consideration uses an example (pp. 178) of a sphere heating and rotating over the same time interval to suggest that referring to events as having the same spatiotemporal location is insufficient to individuate events. These considerations entail sole use of spatiotemporal location as a principle of individuation is partially complete, forming necessary but not sufficient conditions for individuation.

We thus come to Davidson's first individuation criterion on page 179, which he appears to regard as involving both necessary and sufficient conditions:

"Events have a unique position in the framework of causal relations between events in somewhat the same way objects have a unique position in the spatial framework of objects. This criterion may seem to have air of circularity about it, but if there is a circularity it certainly is not formal. For the criterion is simply this: where x and y are events:

$$(x = y \text{ if and only if } ((z) (z \text{ caused } x \leftrightarrow z \text{ caused } y) \text{ and } (z)(x \text{ caused } z \leftrightarrow y \text{ caused } z))."$$

Davidson defends this proposal by discussing how it explains why we (epistemologically) identify events, and why we describe events in terms of their causes (as in his 1980 [1967c] above) and effects. In order for the epistemological principle to work in a realist way, then, one needs to postulate the existence of events with such an ontological criterion. (After all, one could conceivably take a fictionalist approach and say that the use of "event" in situations like these are similar to the use of mathematical objects in factual contexts: see chapter 1.)

Thus, both the evidence for the existence of events and the criterion for individuation involve a semantic and epistemological realism. Note that because the notions of causation are intimately connected to those of events in this understanding, our understanding of causation thus lends support to the existence question for events as well.

But, Davidson's views shall be expanded upon slightly. His 1980 [1970a] paper, "Events as Particulars" explores several characteristics of events. These lead to some implicit consequences for individuating events, so this article also bears on my primary project as well. Davidson's starting point in this work is again partially semantic in focus. This leads him to suggest that not only that there are events, but also that they are unrepeatable particulars (concrete individuals). Davidson obtains these viewpoints from considerations of such sentences as "the storm in the hills last night" which appears to make reference to "the storm," something which is grammatically a particular. This is like how "the hat was blue" refers to a particular hat.

Further, because we can use such locutions as "The third explosion was more destructive than the first two" (pp. 181), Davidson suggests that events are dated. Note that because (at least prerelativistically) an event would thereby get a (reasonably) unique date, this can form one part of (another?) *principium individuationis* for events. It is unclear whether this is a necessary condition, however. It cannot quite be the whole story, because it seems plausible to suggest that events could be in the same place at the same time. After all, things (e.g. an electric field and a gravitational field, at least as normally understood) can be in the same place simultaneously. We have met this consideration above; Davidson himself had raised it earlier.

But (to his credit), Davidson also recognizes (here) the possibility that our grammar could be misleading. We do not

have a fully worked out theory of reference. If we did, we could determine to what degree our sentences concerning events were true, and hence to what extent events are important in the actual world. Because this leaves the possibility that an alternative conceptualization will work just as well or better, Davidson's primary burden in this paper is to show that his critics' proposals do not work better. His primary focus is on Chisholm (1970). I shall briefly explain his paper to set the stage for what Davidson uses from it to expound to his own view.

Chisholm's paper's stated goal is to account for an apparent feature of events. Chisholm (pp. 15) suggests that any theory of events is not complete unless it includes recognition and reconstruction of the fact that events recur. If this were so, this would affect our understanding of the individuation of events. For instance, yesterday I emailed Harvey, and today *I did it again*. The "I did it again" locution's "it" seems to suggest if taken literally that something recurs and hence an individuation principle should recognize the "repeatable" nature of events.

Chisholm surveys several possibilities to solve the problem he has raised. The first of these concerns making use of types of events and saying that two tokens of the same event type took place. Concerned with ontological economy, Chisholm rejects this proposal. Chisholm also rejects for the same reason (pp. 15) the idea that one event occurred at a time t , and another at a time t' because supposedly that commits one to the existence of objects called "times."

Instead, according to Chisholm, there is one event, an emailing of Harvey that occurs at both times (pp. 15). Chisholm's solution instead makes use of an object that he calls a "negation of the event." For each event "p," there is a corresponding negation of that event, written " $\sim p$." For instance, there is negated event " $\sim e$ " between the two events e . In other words, to return to my emailing example,

there is an emailing, followed by a non-emailing, followed by an emailing.

Some other clues on how to understand "p" and "~p" are given when Chisholm also asserts that there is a commonality between events and propositions, stating that both are species of what he calls states of affairs. These in turn are any objects which can serve as the objects of belief, hope or other intentional attitudes. It is also unclear what sorts of objects this criterion rules out and hence what sorts of objects Chisholm thinks events are. Nevertheless, events (according to Chisholm) are the states of affairs which are not propositions and which "imply change" (pp. 20). Chisholm gives examples of the latter clause but does not elucidate it very much. Chisholm's own solution to the problem he raises is thus: an event e occurs; ~e occurs; e occurs (again). As events are literally repeatable for Chisholm, he has thus made them into universals.

Let us return to Davidson, then. He finds Chisholm's views implausible, and surveys four possible explanations and elucidations of the putative fact of event recurrence (including Chisholm's own). These are: first, events that have parts that are themselves events, and the parts may be discontinuous spatially or temporally (pp. 183). On this view, there is a single (but interrupted) event which occurs both yesterday and today. In this sense, the event of an emailing occurs yesterday and it continues today. Davidson does not regard this as a solution of the problem that Chisholm raised. As he says (pp. 184):

"Is it plausible that when we say 'Jack and Jill got married in May, and Dolly and George did the same thing in June' we are saying that the event-sum of all marriages continued after a pause? Perhaps: 'The marrying resumed in June with Dolly and George.' But I confess this seems strained, and the reason is, I think, that our common talk is careless when it comes to identity: 'the same thing' often means 'something similar' or 'another': [...]"

A single event occurring, albeit interrupted, is not the

repetition of an event, but one event continuing. It also seems unnatural to speak of all the marriages as parts of a larger one.

Davidson also rejects Chisholm's solution (pp. 183 and 185-6), namely, that there is an event *e*, followed by a negated event ($\sim e$), followed by *e* again. His rejection is based on it failing to yield a viable semantics of adverbial modification. As such a semantics is the original motivation for Davidson's metaphysics (see section one), Chisholm's views are clearly unsatisfactory.

Next, Davidson also mentions in passing another solution, one that Chisholm himself considered but rejected, namely that two token events of the same type occurred. Davidson sympathizes with the attempt to avoid event-kinds, and so suggests a fourth solution. This solution makes use of the fact that we are ordinarily quite lax in our talk of identity anyhow; perhaps all we mean is similarity in these cases. As Davidson puts it (1980 [1970a], pp. 184):

"If I am right, talk of the same event recurring no more requires an event that happens twice than talk of two tables having the same width requires there to be such a thing as the width both tables have."

(Note: this creates a tension with Davidson's understanding of events as having properties, as often properties suggest kinds. It is not clear how Davidson resolves this issue. Since I have no problem at all with events falling into kinds, I do not regard this as damaging to Davidson's view.)

Davidson suggests that this consideration alone does not make Chisholm's view mistaken, just that his own account of events is adequate in the way that Chisholm claimed it was not. Davidson then turns to analyzing the difficulties with Chisholm's account. Chisholm is said to deny event identity in contexts that seems intuitively appropriate (pp. 185).

"Chisholm argues (to switch to his example) that Nixon's being in Washington is not the same as Johnson's successor being in Washington,

since we can say of the first event, but not of the second, that had Humphrey won, it would not have occurred. If this were a good argument, we could unhinge other true identity-statements: compare 'We can say of Nixon, but not of Johnson's successor, that had Humphrey won, he would not have been president. Therefore Nixon is not Johnson's successor.'"

Davidson analyzes this mistake as being primarily due to Chisholm's insistence that there is only one event of each kind (pp. 186). But, he says, this breaks commonly accepted inferences with sentences concerning these events. Davidson lists several other problems with Chisholm's views.

Most important for our concern are Davidson's analysis of sentences of the form "The moon rose after the sun set" (pp. 187). This also "dates" events, as Davidson renders this as "There is an event x that is a rising of the moon, an event y that is a setting of the sun, and x came after y ." It is also important to note that Davidson's analysis also implicitly leaves the door open for spatial location to be a (perhaps) necessary but not sufficient part of a principle of individuation for events. We thus have time as an "index" on the event structure. This is because Davidson allows analyzing sentences into forms that make an explicit reference to event location. On page 186, he makes use of a "took place" locution for events, so again, presupposing his weak realism, it is difficult to understand why Davidson did not make use of location in a criterion of individuation at this stage.

The preceding paper was not the end of the debate between Davidson and Chisholm. "Eternal vs. Ephemeral Events" (Davidson 1980 [1971]) continued the debate after a symposium paper by Chisholm appeared. Davidson claims that the disagreement between him and Chisholm is not on what entities (objects) exist (pp. 189) but instead about how to do semantics (which Davidson helpfully calls "the study that relates language and ontology"). Thus, one expects the metaphysical differences between the two to be slight or nonexistent; I can thus ignore this latter argument with Chisholm in this work, *qua* argument.

Instead, let me examine Davidson's paper for any further elucidation of his position. One area of elucidation is the possibility of properties of events. This is not to be confused with the "property exemplification" view of Kim's we shall meet later and I adopt in part in the sequel. Instead, it concerns the issue of features of an event itself. Davidson (pp. 191) suggests there are predicates true of certain events; this in turn suggests that there are properties which are possessed by them. For instance, an event expression may be truthfully substituted in "x is fast," or, perhaps somewhat differently "x is an explosion." It suggests in turn that events do indeed fall into non-singleton (pace Chisholm, above) kinds. This discovery helps our general problem, this time speaking to the "existence" problem as the ability to group into somewhat "natural" classes does suggest that we are indeed "carving the world at its joints." It would be odd if there were events but no kinds of events.

I now sum up all these views of Davidson, for these are the ones which he has more recently been criticized for and further, has modified in the light of charges of circularity. At this stage, then, we have seen that Davidson holds that events are individuable by cause and effect, that they occur at a specific location and duration (spatiotemporal interval), they are concrete and unrepeatable. Furthermore, events themselves possess properties of their own, much as things do, and hence might be said to fall into kinds. Note that this latter point is not endorsed explicitly by Davidson, but is a consequence of his views, as we have seen above.

In Davidson's (1985) "Reply to Quine on Events," we find him modifying his views on individuation in response to circularity charges from Quine. Quine (as we shall see in detail in the following chapter) argues that Davidson's account of events is regressive as it requires individuating events in terms of their causes and effects. But, these in turn are also events, so there are no end of events needed to

individuate a given event. In response to this objection, Davidson concedes that his account is circular (1985, pp. 175):

"He says my suggested criterion for individuating events is radically unsatisfactory, and I agree."

Davidson thereby changes his mind on what individuates events. He adopts formally what he calls Quine's criterion (as we have seen, he has implicitly held this as a necessary but not sufficient component of his since at least his 1980 [1970a] paper). This is the view that events are individuated solely (or almost so) by spatiotemporal location. Davidson explains his motivation for having avoided committing to this view earlier. Most instructive for our purposes is his remark that he had previously been skeptical about using this as a criterion as it appeared to him to require identifying events with things. Davidson was also originally concerned with issues of vague boundaries for objects in general, but since they apply to things, he is not concerned¹⁹. Here, he distinguishes events from things, noting that events are changes, things are that which undergo changes. (It may turn out that events themselves can change, but this is not considered by Davidson.) Interestingly, he says that spatiotemporal locations are not quite enough to distinguish events from things and from each other (1985, pp. 176), but our grammar - in particular predicates - do, and that's enough for him then. Since Davidson's basic motivation from his (1980 [1967a]) on was a weakly realist theory of reference, it is odd that he did not latch on to this as suggesting the importance of properties for a principle of individuation for events.

I have introduced four recurring metaphysical problems. These are that of ways to show event existence, that of the "connections" between events and things, that of the

¹⁹ This is not to say that Davidson is unconcerned with identity conditions for things as an important philosophical project, he is merely uninterested with it in the context of the current paper under discussion.

"connections" between properties and events, and finally, that of the criteria of individuation for events. These are those which Davidson grapples with throughout his work on events. I have suggested that the question of individuation is to be the central concern of the current work as two of the others are strongly interrelated to it. The arguments concerning event existence I shall leave pretty much alone, as I regard none of the counterarguments terribly convincing.

The next chapter concerns more substantive discussion of criticism that Davidson's account has received as it pertains to metaphysical concerns, and will meet most of these objections on Davidson's own terms. I shall not concern myself with strictly semantic considerations, as mentioned in chapter one. This is because semantic critics of Davidson agree that semantic considerations could only affect the existence question, as of the four issues of this chapter Davidson relies most heavily on semantics to develop his argument. All the semantic critics agree that the existence inference survives their proposed modifications. Hence, the objections we shall meet to Davidson's account in the next chapter (from the literature) are primarily metaphysical.

Chapter 3 - Davidson and his Critics

This chapter consists of four sections. The first of these surveys various objections to Davidson's views on events found in the literature. I shall answer most of these criticisms on Davidsonian terms, with some parts of the responses held until I have developed my own account of events in chapter four.

The second section consists of discussions of rival conceptions of events, those of Kim, Bennett and Lombard. Similar to section one, I shall meet these objections on somewhat Davidsonian terms. Some other criticisms shall be from metascientific considerations.

The third section considers the charges of regress put forth against Davidson independently by Quine, Lowe and Bennett.

The fourth of the sections is my own criticism of Davidson's account based on considerations from special relativity. I include several remarks that set the stage for the solution to this problem and an incompletely resolved objection to Davidson from the third section.

Section 1 - Defense of Davidson Against his Critics

I shall survey in this section: Chisholm's charges that there are no such objects as events, and states of affairs should be "used" instead; Sanford's worries about event composition; Savellos' objections concerning change and finally Mittwoch's objection that Davidson is relying too much on English grammar to obtain his data on events.

In each case where Davidson has responded to the criticism, I refer to, I shall provide my own independent responses in more or less Davidsonian terms to demonstrate the robustness of his account.

Chisholm (1967) was one of Davidson's earliest critics. He

tells us that events are dispensable; instead we can talk of states of affairs. Davidson (1980 [1967b], pp. 122-148) has admirably dealt with much of what Chisholm defends. However, there is also a quicker avenue that shows Chisholm's account has a potential problem. Chisholm's first definition of a state of affairs is as follows (1967, pp. 109):

"p is a state of affairs = Df p is possibly such that there is someone who accepts it; and there is something which obtains and which is necessarily such that whoever conceives of it conceives p."

This has the unfortunate consequence that it makes the notion of a state of affairs dependent on the notion of a person. Since it seems plausible that one could want to characterize the notion of a person in terms of a state of affairs, this definition is lacking. Chisholm's definition would make this move impossible.

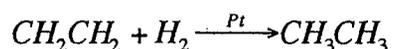
Sanford (1985) is worried about causal composition (pp. 288) and whether events are the only subject of the causal relation. He writes (p. 288):

"One argument of Davidson's seems to be a lapse. 'It cannot be that the striking of this match was only part of the cause, for this match was in fact, dry, in adequate oxygen, and the striking was hard enough.' What prevents us from constructing parallel arguments, each showing that something else cannot be only part of the cause? 'It cannot be that the dryness of this match was only part of the cause, for this was the dryness of a match which was in fact struck, hard enough and in adequate oxygen.' If we assume that only events can be causal relata, then it is reasonable to hold that the cause in this example is the striking. Abandon this assumption, and I see no good reason not to count the striking's being hard enough, its being of a dry match, and so forth, as distinguishable causes of the match's lighting. Allowing parts of causes, in this fashion, should not prevent us from drawing Davidson's important distinction between causes and the features we hit on when describing them."

Sanford's issue is thus with (what one might call) the mereology of events with other objects, properties, etc. He calls some of these; those involved in the event in question proper (pp. 283) "event aspects." Other objects and properties are equally parts of causes but are not necessarily related to the event which Davidson would consider the cause in question. All of these "sum up" somehow to produce causes. Must Davidson admit that causes need not

be events and could instead be any of these event aspects, related conditions or their sums? I answer in the negative for Davidson. There are two reasons to suppose this. First, an article by Lombard (1990, particularly pp. 201) can help. Lombard argues that there is a distinction between enabling conditions and causes. In particular, he argues that enabling conditions allow causes to be efficacious. Some of what Stanford would call parts of causes (for instance that the striking of a match was in adequate oxygen) are enabling conditions, according to Lombard.

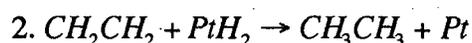
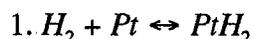
I believe (on metascientific grounds) that Lombard's distinction is vital. Forces are causes in Newtonian dynamics, but to solve any problem in dynamics one cannot make do with just the forces involved. For instance, if we want to calculate the position of a particle after it undergoes the influence of a force, we must know the initial position of the particle and its initial momentum. These are examples of what are known as boundary conditions in the theories of differential and difference equations. Different kinds of variables are involved in causes (forces) and initial conditions. No "combination" of these in any mereological sense is needed here; Davidson thus need not concede Sanford's problem about event mereology. It is important to realize also that many "boundary conditions" in certain cases may play roles of allowing an event to happen faster or slower than it otherwise would have; these may also provide actual (i.e concrete) boundaries of a system to enable it to undergo an event. Both of these are the case with chemical catalysts and inhibitors. In the reaction elliptically represented by



the platinum used makes the reaction fast enough (and hence produce enough ethane in a reasonable length of time) to be used industrially, but the reaction does proceed (though extremely slowly) without it. Also, note that (by definition of catalyst) it is not a reagent in the net reaction, hence overall event. No causation can reasonably be attributed to

the platinum at least at this level of analysis. However, this case does illustrate the composition of events with each other.

This is because we know from the study of catalysis that the reaction above can be broken down into two sub-reactions. We know that the following (again, elliptically represented) reactions are likely (independent of the considerations of the overall reaction considered):



Thus, by the success of science argument, events do combine into larger events. But, it appears plausible to suggest that this is one event - after all, a similar change does happen (slowly) independent of the catalyst. I shall make use of this compositionality again in chapter four.

However, in practice it may be difficult for us (as limited humans) to specify the two (or more) kinds of things involved in an event (as in the case of a complicated solvolysis reaction, for instance, where the solvent acts as a boundary condition and an active participant in the reaction) in this sort of case, but that is an epistemic problem, not an ontological one.

Second, there is another metascientific reason to avoid placing non-event items as relata of the causal relation. If one, as above, accepts that forces are events and yet one believes that other, "event aspect" objects and properties are also the relata of the causal relation, one has to account for how they mereologically "sum up" to produce resultants, as Sanford suggests. (Note that this affects the problem of event individuation - what distinguishes events from the other objects they are summed with, how does this work, etc.)

The use of boundary conditions (as above) with conventional

vector addition is well-understood both ontologically and epistemologically. But, it is unclear how to put other features on a par with events, as causal relata. Consider the case of Newton's second law: $\vec{F} = \frac{d\vec{p}}{dt}$. To determine the net effect of two forces, simply add the two force vectors, and the net change in momentum (\vec{p}) will be as if it were one force on the body in the direction of the resultant. Suggesting that the features of things involved in the event are causal relata (on an equal footing with the forces) would seem to involve counting the mass twice. Sometimes one does this in some sense (consider the case of a gravitational force on the thing in question) but there it is again to produce another force, another event, not to raise one property of the thing up to the status of direct causal relata.

One of Sanford's examples (1985, pp. 288) to show that event features matter is the case of someone who fell to his death with two different hypothetical weights, 168 and 368 pounds. He claims in the latter case that we are more likely to say that the falling man's weight made a difference to his dying, hence was a cause of his dying. I argue that this is a mistake. Consider a very elementary model of the situation²⁰, one where the magnitude of the force (the event) is proportional to the kinetic energy of impact; then the relative contribution of their masses is simply:

$$\frac{F_1}{F_2} = \frac{K_1}{K_2} = \frac{\frac{1}{2}m_1v^2}{\frac{1}{2}m_2v^2} = \frac{168}{368} = 0.457. \text{ The "event aspects" are already}$$

built into our understanding of the event (the falling, or perhaps the ground-hitting) and its effects. Ordinary language is simply imprecise on this point.

In light of the above considerations it can be seen that some of Lombard's views (concerning the distinction between

²⁰ I have no idea whether this simple case is at all correct. Nor does it matter - it simply illustrates how "event features" can already play a role in understanding events scientifically.

enabling conditions and causes) partially complement Davidson's. However, it should not be said that Lombard's views on events are entirely in agreement with Davidson. In his (1986) book *Events: A Metaphysical Study*, he examines Davidson's criterion of individuation. Here, he asks a question about it that Brand had previously asked and Davidson had not responded to (pp. 76): can events have no causes or effects, and if so, how are they individuated? After all, if there are causeless or effectless events it appears that they would be individuated as "one." Note that Davidson's adoption of spatiotemporal location as part of his criterion of individuation does not help here, since if two or more of other kinds of events can be spatiotemporally identical, so could some without causes or effects. Nothing about them being causeless or effectless would rule out their sharing a location.

But are there events which have no cause and no effect²¹ ? There are plenty of happenings that apparently occur without cause (e.g. radioactive decay), but I submit that we know of none that have no effect, and with good reason. A possible counterexample (that I thought up) apparently would be a radioactive decay within a black hole. But, this event is not quite effectless, as it would increase the entropy (and hence surface area) of the black hole. This increasing in area is an event. For Lombard's concern to go through, he has to show there are events with no causes and effects. This seems *prima facie* implausible as an effectless event violates the well established basic conservation laws. These laws are so incredibly well established I regard it as impertinent not to rely on them in a science oriented metaphysics. To say that an event is effectless is to say that it "does nothing." If it does nothing, then any changes in properties that occur in the event cannot be "compensated for" in another event. The question then becomes: do all events involve changes in at

²¹ Since I am not a fan of "possible worlds" metaphysics, I refuse to consider the issue in these terms. I only intend to investigate the only possible world I know - this one. This should not be read as a commitment to actualism.

least one fundamental property (momentum, energy, angular momentum, etc.)? The answer would appear to be yes, for such events occur at the most basic physical level and all other events emerge out (or supervene on) of all these lower ones. Conservation laws are taken for granted in higher level sciences and technologies for this reason. For example, a nutritionist takes energy conservation for granted when examining the diet of a patient.

I shall return to a few more of Lombard's views a bit later as they pertain to saving Davidson from the regress charge I have foreshadowed and to make a brief remark on his use of quality spaces.

Savellos (1992) has two principle criticisms of Davidson: first, that Davidson's criterion restricts the properties relevant to the principle of individuation to causal ones (claiming that events have other important features) (pp. 810), and second, that his criterion may not recapture the intuition that events are a kind of change. The first of these objections is closer to being correct: Davidson's criteria of individuation is only terms of causality²², it is not surprising that Savellos felt Davidson had left the possible change in properties out. Davidson can answer this charge pretty much directly by saying that he does not care what undergoes the change in a cause-effect relationship, only that something does. Of course, as we shall see, Davidson needs to make use of some notion of property anyhow to refine his account. I shall discuss this more, in section two below and then in detail in chapter four.

As for Savellos' second criticism, I believe this objection to rely somewhat too heavily on one's intuitions about time and causation. As has been pointed out recently (Hitchcock 2000), people differ wildly on their intuitions about causation. Causation in my view (and presumably Davidson's)

²² Causation and properties shall be dealt with to the extent they are needed for the present work in chapter four, particularly the first three sections.

seems to require change, but it is certainly possible that Savellos does not share that intuition. Furthermore, and slightly more contentiously, Davidson's use of times also somewhat implicitly allows for some change; there is no time without change. (I shall not argue this point and merely take it for granted. See Bunge 1977, particularly chapter 6, for a discussion of this point.)

However, Savellos correctly points out that this latter feature of Davidson's account (i.e. that events are necessarily involved with change) does not necessarily establish the "right kind of change"; it is consistent with the rest of the universe changing and the thing undergoing the event remaining static. I concede this point, but it is important to note that it ignores Davidson's suggestions about spatiotemporal location. Once he overcame his initial (1980 [1967a]; 1980 [1967b]) skepticism, Davidson had no problem with localizing events. Nevertheless, Savellos does have a genuine beef here as it is unclear what "location of an event" amounts to according to Davidson. I shall postulate that the spatiotemporal location of an event is the least spacetime interval in which it occurs (see chapter four). Note that this makes the location of an event relational, as one might expect. But, the issue of relativity must await section two and later, below. Davidson himself does not directly answer this concern.

Mittwoch (1998) has raised an interesting possibility concerning Davidson's original source of information about events. She points out that Davidson's analysis of sentences was in English, and that other languages have different semantic features, and hence possibly different implicit referents. Nothing much metaphysically different comes out in the language of her choice (modern Hebrew) but the issue is raised whether (for instance) Chisholm's or Kim's (or some other position's!) intuitions rather than Davidson's concerning events could have been obtained by an analysis of another language. I see no easy way to resolve this debate, other than show (as I hopefully have done in chapter 1) that

Davidsonian understanding of events is scientifically useful. We thus have an independent check on the metaphysics produced by the linguistic analysis. We shall also meet (in chapter four, section four) an explicit claim (Bartels 1999 [1998]) that Davidsonian events are the events in quantum field theory and I shall also argue (section five) that events are generally scientifically indispensable.

Another way to address Mittwoch's concern would be to see whether languages very much unlike English allow the analysis that Davidson does in English. Since there is little sense in investigating a distant language if a nearby one fails to work, I will first illustrate that one can "Davidsonize" (to borrow a term from Peterson 1990) in French. Consider the phrase: "J'ai conduit mon auto vers Washington." Intuitively, this entails (e.g.) "J'ai conduit mon auto" and "J'ai conduit." Thus, one renders it as (e.g.): " $(\exists x)(\text{Action de Conduire}(\text{Moi},x) \ \& \ \text{Avec}(\text{Mon auto},x) \ \& \ \text{Vers}(\text{Washington},x))$ " - which says: "Il y a un événement qui est un action de conduire, il utilise mon auto, et il est vers Washington." So French sentences intuitively about events can be Davidsonized. Note, however, the great difficulty of showing that all the relevant sentences of a language can be Davidsonized in a similar way to those in English. I shall take a risky inductive leap on this issue as it pertains to French. Let us now look at a language very much unlike English.

The language Nuu-chah-nulth (formerly called Nootka), spoken by some First Nations people in British Columbia, can be Davidsonized. It, however, illustrates Davidson's point that one cannot merely look at the functioning of participles in a language to determine if it refers to events, because in this language participles can be used in radically different ways compared to their uses in English. For instance (Wojdak 2001) one can say "naniqsa-k-it-qs" which apparently has the grammatical form of "my grandfathered", according to Nuu-chah-nulth/English bilinguals. A similar modification applies to many lexical items we would call nouns. It would thus

appear that Nuu-chah-nulth disagrees with English on event places (if Davidson's semantics are still to be adopted) and hence threatens to turn many more objects into events - if the argument from semantics a la Davidson is correct. We might call this the "everything is an event" consequence.

But, in English the previous sentence means "my late grandfather." Davidson's analysis avoids the pitfall of saying that this sentence refers to a "grandfathering," which could be an event in another context. How is this translation done and this pitfall avoided? By noting that while it appears there is no noun-verb distinction and hence apparently has the "everything is an event consequence," this appearance is misleading.

That is because the language does make the noun-verb distinction along the same lines as English, it just allows what are ordinarily verb modifications to apply to nouns as well. Other features of nouns remain intact, allowing one to distinguish verbs from nouns, etc. and hence events words from thing words.

Hence, all the event words and the phrase structure that they build up are similar. We can thus in principle Davidsonize in Nuu-chah-nulth, being careful to not Davidsonize the nouns that "look like" verbs. This conclusion is, of course, very tentative, as much data is needed to establish it more securely. Further, since again it is only one of the world's language's, Mittwoch's issue could only realistically be addressed by surveying the world's languages, or finding some sort of mechanism which would explain the absence or presence the possibility of Davidsonizing. (The latter would presumably be a finding in neurolinguistics.) Both of these are monumental tasks hardly begun. Because of the incompleteness of this research, I leave Mittwoch's question open.

Section 2 - Rival Views

I turn now to the second section of this chapter, concerning

various alternative accounts of events with some currency in the literature. The most prominent of these is Kim's. The primary distinguishing feature of Kim's elucidation vis-a-vis Davidson's is the use of properties. Because the new account of events proposed in the present work makes use of this notion as well, Kim's account bears examination in some detail. I shall first lay out the view and then criticize it.

The central thesis of Kim's view is that events are the exemplification of a property at a time or duration, representable by writing it in the form $[x,P,t]$. Kim includes within his conception of an event what are often called states and conditions (1993, pp. 8), not merely objects involving changes. He rejects Davidson's account because it does not analyze the inner constitution of events (pp. 12). This is a bit unfair, as Davidson would probably reply that he did not feel it was necessary to do so to perform the tasks he wanted. He would simply say that the inner constitution of events is not needed to individuate them. (As I shall show later, this will turn out to be false, but Kim at this stage doesn't show that.)

Kim's account thus involves an internal individuating principle, Davidson's an external one. He suggests that Davidson overlooks the distinction between what he calls the constitutive properties of an event and the exemplified properties of one.

An example of this is as follows. Consider the case of the event represented by [Audrey,logicizing,yesterday]. Logicizing is a property constitutive of this event. Occurring in Buchanan D330 is exemplified by this event. In

other words, some properties are "involved" in the event²³ and some properties are of the event.

Kim argues for the "possibly static" view of events (my terminology, so called this because they do not not necessarily involve change) as follows (1993, pp. 34):

"When universal determinism is formulated as 'Every event has a cause' or 'the aim of science' is said to be the explanation and prediction of events in nature, it surely is not intended that states, narrowly so-called, escape the net of causal relations or that it is not the business of science to obtain why certain states obtain, e.g., why the sky looks blue or why the earth is pear-shaped."

One can reconstruct the argument in Kim from the preceding as having the following form (one can reconstruct a parallel one using his example of universal determinism)

(1) Science ought to explain and predict states.

(Premiss)

(2) Scientific explanation and prediction is exclusively causal. (Premiss)

Hence:

(3) Scientific explanation ought to be causally explain and predict states. (from 1, 2)

But:

(4) For all explanations and predictions x, if x is causal, then x involves appeal to events. (Premiss)

Conclusion:

(5) States, to be scientifically explained and predictable, involves appeal to events (from 3, 4)

The argument is valid, as the notes on the deduction above

²³ This is easier to see if one temporarily relaxes the condition that events need not be changes. It is sometimes hard to understand what properties are said to be involved in an "unchange event". This is another (related) weakness of Kim's view - it threatens to turn all unchanges into the same event by involving all the unchanging properties in the universe. For instance, does the unchange of the sky's colour involve the unchanging chemical nature of xenon in the atmosphere of Mars?

indicate. I shall grant Kim's (1) and (4), but find his (2) objectionable. I argue that we don't need to make use of the concept of causation (and hence have no need of a broad, Kimian concept of events) to understand why (to use his example) the sky stays looking blue. A perfectly good explanation of the blueness of the sky in terms of states alone can be given, without the use of the concept of causation. I give one in the following paragraph.

Since the wavelengths of incoming light (from the sun) are relatively constant, their intensities are constant too (given that the angle of scatter across the sky is the same because the earth is far from the sun). Thus, the blueness is a product of microevents, to be sure, but the macro-occurrence of the blue is not itself an event because it is just what might be called the "phenomenological sum" of many tiny events. The constancy of the colour of the sky is thus strictly an appearance to us. The apparently global nature of the occurrence is a product of our psychology (which of course relies on events, but in another way.) To see why this global nature is phenomenal, consider Rayleigh scattering - the accepted explanation for the blueness of the sky, summed up in the following equation (after Arion et al. 1958, pp.

1460): $I = k \frac{1 + \cos^2 \theta}{\lambda^4}$. There are no global properties of the

atmosphere (e.g. its volume) represented in this relation, hence, it must be "in us." Instead, we have the angle (θ) of scattering and the wavelength of light (λ) incident in the scattering, related to intensity (I) of that given light, not "all the light" - all the light together results in the atmosphere's global appearance. All the microevents add up to a persisting state, (of intensity and wavelength) which we experience. Note finally, the above statement is not a causal law statement - it involves no forces or potentials. It does not even relate changes, though it entails several equations

that do (e.g.: $dI = -4k \left(\frac{1 + \cos^2 \theta}{\lambda^5} \right) d\lambda$).

Two other very well-known examples where states play an explanatory but non-causal role are Newton's 2nd law (the law of inertia)²⁴ and the case of radioactive decay of a large body of radioactive material.

Under the standard understanding of quantum theory, the body undergoes radioactive decay spontaneously without outside influence. The rate law does not depend on anything but the internal properties of the body in question. It is true that the origin of a state is causal, but that is rather different from the persistence of one. For instance, we might investigate the event that brought it about that the earth is pear shaped.

Furthermore, if existence is a property, then everything for the entire lifetime (infinite or otherwise) of, the universe is "undergoing" a Kimian event: the event represented by [the universe, existence, all time]. Calling this an event is very odd as at least on some views, the universe (taken *sub specie aeternitatis*, as one would have to, to get anything like a "global picture" of it) is not an event in any ordinary sense as it does not take place in anything. The universe is simply what is (taken tenselessly).

Admittedly, these considerations are not conclusive, but they do show that perhaps the theses Kim wanted to support by his narrow conception of events were unfounded. At this point one could throw up one's hands and just claim that one has differing intuitions about how a word is used and leave it at that. If Kim is unswayed by the above remarks, so be it. I do not regard "nonchanges" as needing causal explanation. This I regard as the lesson from the inertia case (etc.) above. One could readmit "nonchanges" by giving up the thesis that

²⁴ The law of inertia states that only changes in momentum require outside influence (forces). This can be seen by writing the law in differential form and that noting that the equation has constant velocity solutions even in the absence of forces.

events are the sole relata of the causal relation²⁵, but this is odd in its own right, and would require more examination of said relation than I have the inclination or the time to perform here. A few more arguments about this latter issue are found in chapter four.

There is another, perhaps more minor problem with Kim's account as stated. Kim provides a mereology of events, and uses symbols like "-" and "Δ" to formalize aspects of this project. If one takes these strictly with their standard meanings, Kim's events cannot be over intervals but infinitely short (pointlike) in duration (as ordinary subtraction operates on single numbers). This produces a slight inconsistency on Kim's account; as we have seen Kim claims that events occur over durations. Alternatively, we could construe a new definition of "-" and "Δ". Wedeking (2000) suggests that "-" be defined on intervals by (second interval earliest time - first interval latest time) where "-" is there read in the usual way. However, this suggestion does not work so neatly with overlapping times. Kim does not seem to recognize the need for further elucidation of the meanings of the symbols. This latter point also suggests a minor inconsistency (or incompleteness) in his account.

Now that we have seen some reasons for not adopting Kim's view wholesale (I shall adopt some of the theses on properties later), we should briefly investigate two other reasonably influential views of events to see why they do not seem as satisfactory a starting point as Davidson's²⁶.

Lombard's (1986) criterion of individuation is very similar to Kim's. Events are individuated by a spatiotemporal

²⁵ It is possible that this is the point of fundamental disagreement between Davidson, Kim and me. I consider alternative characterizations of the causal relation briefly in chapter four.

²⁶ It may be noted, especially after the account is fully developed, that the position on events in the present work owes as much to Kim as to Davidson. This may be right. Nothing (except my title!) hangs on this distinction.

location and a property space, instead of merely one persisting property. He does suggest that events are movements within a quality space, but quality spaces are fictitious under most accounts (i.e. they are ways in which we understand changes of properties, for example, the Hilbert spaces used in QM.) A critic may wonder why Hilbert spaces are fictions. They are such because mathematical spaces are unreal (are constructs) - they (at best) represent real things. Another example can be drawn from the study of automata. The finite automaton depicted below has a one dimensional state space, but the actual structure of what implements it is irrelevant.

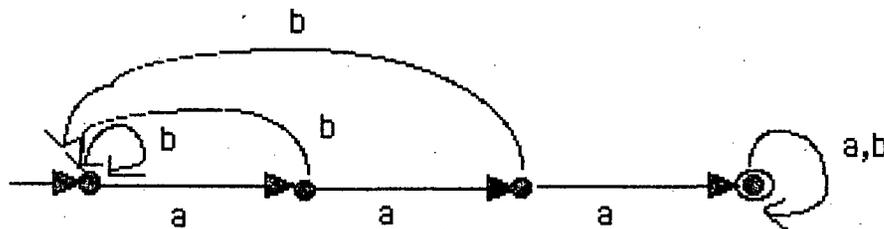


Figure 3.1.1: Finite automaton.

The structure that implements the automaton can be virtually anything at all. Computer programmers don't even have to worry about such material organization. Again, a representation via a state space is not the object concerned.

I reject the state/quality space as being suitable for an ontological criterion of individuation, because state/quality spaces are (one way) how events might be represented to us, not how they are in themselves. After all, events were individuated before there were representers and there will be events long after the last representer (and her created quality spaces²⁷!) is gone. Note that I am not accusing Lombard of being a subjectivist; I merely state that his criterion has that consequence. Furthermore, quality spaces

²⁷ Note that the predicates involved in setting up a quality space (ought to) correspond to real properties. I am not denying this. What I am doing is denying that the resulting mathematical space is real. See the first appendix for a definition of the two different meanings of space which might be the source of some confusion in this area.

change dimensions (Wiberg 1971) when an individual's kind changes. For instance, when two chlorine atoms react with each other, the property of being able to perpetuate a hydrogen chloride formation chain reaction disappears; this would be represented as losing the part of the state space attributable to the lone electron on a single chlorine atom. Movement in a single quality space thus cannot even describe events which are changes in kind. Lombard's criterion thus cannot epistemically account for many important events (e.g.: chemical changes, speciation, etc.)

Bennett's (1988, pp. 88) more ontologically satisfactory criterion is as follows: an event is an instantiation of a property at a zone. In turn, a zone is delimited by a substance and a time. This zone has several properties over its temporal dimension; this is the event. Bennett's account is also a poor choice of a starting point for a view on events as it asserts that a property change (within a zone) is sufficient for an event. This is necessary but not sufficient: I accept Davidson's insight that causes link changes, hence (some) events are connected to (some) others and that this linkage is essential to the notion of event. Unconnected changes form larger events (by zonal fusion) on Bennett's conception. For instance, the growing of grass outside my window is very close to a paint peeling - their zones. Do these thereby compose one larger event, independent of any causal connection? It threatens also to make all events in the world combine into one, a prospect I dismissed as unfortunate previously. As stated before, the entire history of the universe as one event seems unfortunate as events are intuitively happenings. But the universe just is (tenselessly), not a happening.

This again speaks to the issue of whether events are real features of the world. If events were necessarily understood as not being connected in any way, and occurred haphazardly, or worse, lawlessly, this would be a good reason to reject their existence as it would mean giving up the fruitful and necessary principle of lawfulness (Bunge 1977, 1979, 1998).

Note also that Bennett's criterion does not speak to the issue of whether events are causes, or how events fit into the causal structure of the world. Since on some conceptions, things are (taken alone) causally inert, Bennett owes us an explanation of what individuates events vis-a-vis things.

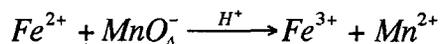
Section Three - Regress Charge

The Quine/Lowe/Bennett charges (1985; 1989a; 1988) of circularity is the most damaging of the objections to Davidson's account. This states that as any event is individuated in terms of its causes and effects and as these latter items are themselves events, each event cannot be individuated without the rest of its causal chain - which (*ex hypothesi*) could be the whole history of the universe. It also would render the account (apparently) epistemologically useless. As Davidson says, we can correctly epistemically individuate events, so something must be wrong with this criterion.

As we have seen, this objection actually resulted in Davidson's dropping part of his account of events and more explicitly adopting another individuation principle. I argue that this was too hasty. I take as starting point Davidson's distinction between events and things and show how to solve the regress problem.

Davidson (1985, pp. 176) remarks that events are distinct from things because events occur at a spacetime location whereas things exist at one. He also writes that events are changes. This prompts the question: what is it that undergoes the change that is an event? Well, a thing. But in what respect? Some changes will produce a new thing; nothing rules out these as being events, but some changes do not result in change of kind. In fact, it is unclear what change in kind **involves** without another species of a change on the table. This is change in properties. A thing may change property-wise in two respects. First, it may change by gaining or losing magnitude of a given property (that this occurs at least sometimes by microscale changes of the thing's

components is of no concern to us here) as when an ion loses or gains electric charge and becomes an ion of a similar but weaker or stronger sort. For instance, in an aqueous solution the oxidation-reduction reaction elliptically represented as:



involves a change in the magnitude of the charge of the iron ions. It may also involve the gain or loss of a property that transforms the thing into a thing of a different kind. For instance, an object may undergo a phase transition, as when the water in a pot boils. Here all manner of properties are lost and others gained, yet the water is of the same (chemical) kind. I shall examine properties more thoroughly in chapter four; for the moment it is important to note how we can use the notion of property changes to break the regress charge.

An event is individuated in terms of its causes and effects, but these causes and effects need not be looked at qua causes or effects, but instead qua changes of properties (of a thing, but that need not concern us just yet). This is similar to Kim's view which involves the exemplification of a property. However, it is Lombardian in so far as it adopts the importance of change being "genetically" connected. In other words, any causal chain can be delineated also by the properties of that which undergoes the change. This is very similar to the "property space" criterion of Lombard, as one might want to say that a chain of events (including a one-item one) is bounded by a property space, but this is a representational notion (as we have seen above.) Ontologically, it refers to how there are "lawful bounds" on the properties of the system.

At this point, I should make clear why I have suggested that we use spatiotemporal location to individuate events. Let us look at an example. Imagine a weight attached beneath a spring which is hung from a height. The spring-weight assembly is momentarily compressed upward, then left to its own motions. The vertical oscillation that results is an

event. It occurs (prerelativistically) in the lab, for (say) 5 minutes. It has causes, e.g. a lab instructor compressing the assembly; and it has effects: e.g. localized wind around the spring. (Neither of these are meant to be exhaustive and this does not matter, on this conception.) Why stop the analysis here? Well, if we include an appeal to properties, we can stop the threat of an infinite regress of causes and effects. Note that this is an appeal to a property (or a pattern of change in a property, if one wants to take the duration of the oscillation as the period for the event).

Thus: an event involves a change in properties of a thing at a spacetime interval which causes other events by this change in properties. The regress occurred only because we had one only one aspect of events in mind. A similar consideration also shows that the effect qua event may not occur right away. The change in properties may occur and then propagate another change sometime later (the effect), thus avoiding collapsing the world into one event. Details for these principles will be in chapter four. This thesis presupposes we can give a satisfactory principle of individuation for properties. (For example, one based on Putnam 1999 [1969] or one of his other suggestions. For instance, a given property might be individuated by the total of all the laws it is involved in, and instances of that by those nomological feature and location.) I do not regard the possibility as likely, but were it the case that properties are individuated in a way that makes this account viciously circular, this account would have to be modified. (Mere circularity is not sufficient, as the primitive features of the world appear to be strongly "ontologically connected.") Further, as noted in chapter one and elsewhere (particularly in chapter four, where properties are examined in more detail), this thesis takes the common property-object distinction for granted.

However, specifying the properties or the causes and effects one needs the spatiotemporal location of the event (and a reference frame - see chapter four). The properties which change in an event are connected and have minimal subjects.

This minimal subject is the spatiotemporal location of the smallest thing which undergoes the event in question. This minimal change may produce a different sequence of property changes, but this sequence is a new event, one of the effects of the first. I take the notion of connected properties as being the ontological counterpart to the arguments from quality/state spaces above. This property change (i.e. one exemplified then another, perhaps several times over the temporal interval in question) does not say anything about the effects of that change. The regress is thus stopped by noting that an event has two aspects. These are: the property change it involves and the causal nexus it is part of. There may be several changes in properties in an event, but these must be linked somehow. They may either be linked by microevents which compose the larger event underconsideration, or they may be connected by being a matter of related properties. For example, in the case of the oscillation above, the length undergoes a pattern of change. In the oxidation-reduction example, the manganese and the iron undergo changes in properties. The event is the change in properties in question, individuated by its cause and effect. But, it is also individuated by this particular change in properties, which never recur (as they occur at a specific time and place.) The exact nature of the relationship between the two parts of the principle of individuation presupposes some understanding of relativity, hence must be put off until chapter four when the new account of events I develop is presented. Property changes are what events are, causes and effects are what an event is produced by and produces. These two aspects of events (property change, causal nexus) are very like a kinematic/dynamic distinction in properties of the event.

If a piece of plastic is melted, its viscosity and its temperature change. This melting affects those two properties (at least); they are interconnected by the internal motion of the plastic molecules and their constituent atoms. This is the "microevent" kind of linkage mentioned above.

An example of another kind of connection between related property changes in one event is the following: being able to chemically bond with chlorine ions is a property of silver ions, but not of silver atoms. So when silver changes electronic properties, it also changes chemical properties. Whether there are any other sorts of connections and how to classify them need not detain us here.

Those who are familiar with the literature on events may wonder why I did not adopt Bennett's (1988, pp. 52-3) suggestion that contact between events be used to resolve the regress problem. I did not adopt this solution as I regard it as irrelevant; whether things have to be in contact (mediated or otherwise) in order to produce change has vexed philosophy and science since the adumbration of the Newtonian understanding of gravitation at the least (Jammer 1962). I shall briefly discuss this vexing problem, and similar worries about the EPR thought-experiment, conservation laws and such like in chapter four, but do not claim to resolve much of the issue. (Though all four fundamental forces (weak, strong, electromagnetic and gravitation are contact forces (Stenger 2000) it was not until "field physics" was developed in the nineteenth century that this became clear.) I should remark in passing that Lowe's (1989a) suggestion that the fiction of null change (analogous to the empty set in set theory or perhaps a null individual in some mereologies) can solve the regress problem does not appear to be fruitful²⁸.

Assuming that the regress argument can be overcome (as above) by inclusion of property considerations in our understanding of events, is the result enough to individuate events? No, it is not, for the reasons articulated in the next section. The gist is that without spatiotemporal location, properties are underdetermined. Causation is still retained as part of my

²⁸ The present author has tried various approaches along these lines to the problem and has met up with considerable difficulty with them. This of course does not entail that it is impossible. Since there is another possible solution - the one I provide - I see no need to pursue this approach any further.

suggested principle of individuation as it situates events in the "network of becoming" and distinguishes them from other objects and from properties themselves. This activity is the key. As I shall also show, we need spatiotemporal location to understand causation. These are the lessons from the special theory of relativity to which we now turn.

Section 4 - Metascientific Criticism of Davidson

As we have seen above, Davidson's account can be patched up by adopting a few Kimian-like features. But this story is not complete. Events would be individuated by their position in causal chains together with the properties that are involved only if the world were Newtonian.

Let us see why. Length is one particularly salient example. Length is an absolute property in Newtonian mechanics; the magnitude of a length is the same in all frames of reference. Durations are similar; similarly spatiotemporal location "fixes" many other physical properties of things²⁹. Causation is similar as we shall see in due course.

Many of these understandings change in the light of special relativity. Length is now known to be a relational property. Forces can have different components of apparently differing kinds in different frames, so causation "works" differently. Not only are the mechanical components of a force relative, but the very kind of forces involved can be. One striking example occurs in the light of the Lorentz force equation.

[$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$]. This calculates the net force (cause of acceleration) on a charged body moving through electric and magnetic fields. It so happens (Halliday and Resnick 1986) that this net force is the same (has same magnitude and direction) in all reference frames. But its components, due to the electric and magnetic fields are not; in some frames the electric or the magnetic field strength is zero - there

²⁹ There are other relational properties possible in a Newtonian world, (e.g.: colour properties and solubility properties), but these are not under consideration here. I shall briefly explore the nature of properties in chapter four, sections one and three.

is no field of that kind in that frame. Thus, causes are relative to particular frames of reference. It, therefore, cannot be such that an event that occurs because of the combined field (e.g. a swerving of an electron) is uniquely specified on Davidson's account, or on the "middle ground" account that we have introduced by introducing the notions of properties.

In fact, this deeper unity between electricity and magnetism is one reason for our speaking about combined fields. But, to understand why this is so, one has to look at the properties involved; merely looking at the effects and causes of E&M related events will not tell you so. Let us take a specific case of the interaction between an electron and another larger charged body to illustrate this relativity thesis. The event we are concerned with is "the coming together" of these two things.

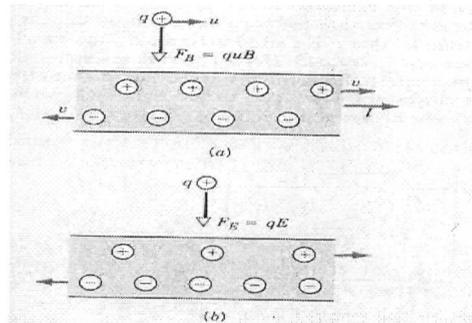


Figure 3.2.1: Relativity of electric and magnetic forces.

In the above figure (adapted from Benson 1991), we can see that different frames "disagree" as to the nature of the force on the electron. In one frame, that of the electron in (a), a magnetic force attracts the electron; in another an electric force - the frame of the wire in (b). Another important feature of this situation is that it illustrates that SR does not make "everything" (or, speaking correctly, all properties) relative (to a reference frame). The effect described only occurs because of the interplay between properties of two different kinds. The quantity of electric charge is *invariant*, i.e. is the same in all frames. I shall

make use of this fact in chapter four.

Note that I deliberately called this event a "coming together" to avoid poisoning the well on which of the two bodies (or both) are to be regarded as in motion. This also suggests that the nature of an event has a relativistic component, which is what we wanted to investigate. The apparent nature of an event is different in different frames. Thus we get the question - what, across frames, individuates events? What makes a cause the same cause, or the properties that change the same properties?

Another argument can be made about spatiotemporal location; an event's location is also relative (one can regard this as the insight of Galilean relativity.) What is surprising and new in SR is the relationship between the velocity and not merely position of an external frame and the rest frame of another object. It is of course, true that in Galilean relativity the velocity of a frame of reference was important (at least calculation-wise), but velocity is not understood the same way in SR as was earlier. (This has to do with the constancy and finitude of the speed of light. See Gibilisco 1983; in gist, this part of Lorentz-Einstein relativity reduces to Galilean relativity in either the $v \rightarrow 0$ or the $c \rightarrow \infty$ limits.)

Because sometimes a single event occurs distributed over an extended thing and because the distribution of locations of the parts of this thing are relative to a particular frame of reference, the single event's composition³⁰ is different in different frames. To see this, consider the case of a radio transmitter. This transmitter beams out two radiowaves from each end of a dish. Now, it may be rejoined that two events are involved here. Not so, as they were sent by one command on the part of the computer operator in the transmitter, and they each carry half of a message for a far away spacecraft.

³⁰ Again, I presuppose that some degree of event mereology is possible. See section one for the initial argument to this effect using the "success of science" methodology from chapter one.

This signaling is therefore one event. (Or, alternatively, the "two" events are genidentical, to use the term used extensively by van Fraassen (1970, pp. 34) for two events which occur to one object) Suppose our spacecraft has standing orders that when it receives radio signals from Earth to piece the binary codes that results together in an interleave fashion and interpret the results in ASCII. It is thus vitally dependent on the order being maintained. To see why, let us say the one is :

{1,0,0,0,1,0,1,1,1,0,1,0,1,0,1,0,1,1,0,0,0,1}

and the other:

{0,0,1,0,0,0,0,0,0,1,0,0,0,1,0,0,0,1,1,0,1,0,0}.

If one puts them together one way one gets³¹:

{1 0 0 0 0 1 0 0

1 0 0 0 1 0 0 0

1 0 0 0 1 1 0 0

1 0 0 0 1 1 0 0

1 0 0 0 1 1 1 1

0 0 0 1 0 0 1 0} = "àãäèLF" (where LF is the linefeed character)

If one puts them together the other way, however, one gets:

{0 1 0 0 1 0 0 0

0 1 0 0 0 1 0 0

0 1 0 0 1 1 0 0

0 1 0 0 1 1 0 0

0 1 0 0 1 1 1 1

0 0 1 0 0 0 0 1} = "HELLO!"

But, the order in which the parts shall arrive is relative to the particular rest frames of the receivers. I have already said they were simultaneous in the rest frame of the transmitter; in some frames they will be different orders, so

³¹ Strictly speaking, one gets no printable characters at all out of the first 40 bits in standard ASCII. I am using the character set from Apple's Courier font for ease of understanding this demonstration. Purists can regard the first message as EOT BS FF FF SI LF if they prefer to ignore the high bits.

the nature of this event is different in different frames, apparently - so how is the signaling one event? Bunge (1979, pp. 67) puts the first point as follows:

"In other words, relativity admits the reversal of time series of physically disconnected events but excludes the reversal of causal connections, that is, it denies that effects can arise before they have been produced, and consequently does not assert the past can be changed. If preferred, according to relativity the time order of *causes* is relative (to the reference system) while *causal connections* are invariant. That is, duration is relative, and the time order of any two genetically disconnected events E and E' can be reversed."

What this entails is that individuating events by their causes and effects does not work - directly - in relativistic physics because these events apparently can be involved with different causes (as the causal order of some composite event might be different) and effects, and involve different changes in properties. For instance, in my previous case of the Lorentz force equation (earlier in this chapter) a thing may apparently experience a magnetic force or an electric force depending on the frame of reference. It would thus appear that these are different events. Chapter four's job is thus to show that this appearance is deceiving. After all, it seems strange to say that an event is a different event in different frames of reference and not merely that it has relativistic characteristics. After all, the thing which undergoes the change is the same thing, though again with some relativized features.

Summing up, an event involves a change in properties of a thing at a spacetime interval which causes other events by this change in properties. It may or may not be caused itself. Understanding which properties are relevant and how, as well as understanding causation, is incomplete in the light of relativistic considerations. We can account for these latter features of the world after we have analyzed how understanding of properties changes in the light of SR. This is the subject of the first section of the next chapter.

Chapter 4 - The Special Theory of Events

This chapter has 5 sections. In the first section I shall develop some preliminary distinctions on the nature of properties. In the second section I will deal with three topical questions about causation. Since both subjects are huge philosophical projects in their own right, these accounts shall only include the minimum necessary to support my own theory of events in the fourth section of this chapter. The third section shall link the concepts of the previous two with those in the fourth by introducing the concept of proper properties, whose understanding presupposes some understanding of causation. In the fourth section, I introduce the new theory of event individuation which is the climax of this thesis. In the fifth section I deal with possible criticisms of the new account of events, responding to (possible and actual) complaints from Davidson, Kim and five others.

Section 1 - Properties: Preliminary Distinctions

We have seen previously (chapter three, section four) that our understanding of properties has to be updated in the light of relativity theories. I shall introduce four positions on properties that I shall take to be understood when properties are invoked in my theory of events.

I additionally discuss four other issues surrounding properties that are taken for granted later in this thesis. First, I shall discuss essential properties. Second, I remark briefly about conservation laws and how they relate to properties and events. Third, I discuss the distinction between the properties of an event and the properties involved in an event. Fourth, general notions of properties and events in relativistic quantum mechanics (quantum field theory) have been investigated by Auyang (1995, particularly pp. 129-132). I shall thus close this section by examining her work on this subject to see how it can be applied to my own purposes.

But first, note that this thesis takes it for granted that objects possess properties, and that there are no propertyless objects.

I suggest that our understanding of properties of factual objects can be divided along four axes: emergent / resultant; intensive / extensive; relational / absolute; qualitative / quantitative. This subsection shall end with a discussion over whether properties are tropes, universals or particulars.

The first dichotomy concerns how properties of a whole are related to properties of its parts. Emergent properties (after Bunge 1977, pp. 97-98) are properties of wholes that are not possessed by their components. For example, the ability to reason is an emergent property of some neuronal systems, as it is not possessed by the individual neurons which compose the system. Submergent properties are the dual of these: properties that wholes lack which their components possess. The ability to think is submergent with respect to social systems; each component of one (a human, say) can think, but the social system does not. Resultant properties are the remaining category (i.e. resultant properties are those which are neither emergent nor submergent in a given context). These are kinds of properties possessed by a whole and its parts: e.g., mass of a molecule. Each atom which is part of a molecule has a mass; the molecule as a whole has one. Another example: the solidity of each macroscopic part of a block of ice gives rise to the solidity of the whole. Note that this illustrates that the emergent/resultant distinction is contextual. Solidity is also emergent relative to molecular properties; single molecules making up a solid are not themselves solid.

Also, note that the first example illustrates another important thesis about properties I shall adopt: namely, that not all properties are directly additive, even ones that

appear to be at first glance³². It is thus not required that properties be completely extensive (i.e. a property whose magnitudes are sums of the magnitudes of its parts) to be resultant as some thought.

This brings us to my third axis, relational / absolute. This one is very difficult to understand, and forms much of my investigation later. A fact is absolute if it occurs relative to all reference frames, and a proposition is absolute if it holds regardless of context (Bunge 1999a, pp. 7). Therefore, an absolute property is one that does not "change" across different frames of reference. It is important to realize that there is no actual change as commonly understood involved in this notion of relational properties (a length across different frames simply is of varying magnitude.) Genuine relational properties are of vital importance later as they will allow denying that certain kinds of apparent happenings are events, and will help individuate others. This absolute/relational distinction for the purposes of this thesis is identical to the intrinsic/non-intrinsic distinction.

In the special theory of relativity, lengths and durations are relative to a given reference frame. Each has in turn a special value in what is called the "rest frame" of the thing in question. This special value is that found in a frame centered on the given object of concern, which is often useful in calculations and investigations and shall be in mine. For example, proper time is a duration in the rest frame of an object, proper length the length of an object in its rest frame. Some properties, such as velocity (if unaccelerated) are always certain values in the rest frame - the fact that a body's velocity is zero in the (unaccelerated) rest frame of an object can be looked at as forming part of the definition of rest frame. Some properties have the same value in all frames, for instance, electric

³² Mass is not strictly extensive as the binding energy of a molecule (or nucleon) affects the total mass of the system in question by the mass-energy equivalence $E = mc^2$.

charge. These properties are said to be invariant³³. I shall generalize this notion in section three of this chapter to what I shall call a "proper property."

As we have seen, however, certain properties "become" reference frame relative because they are "made up of" properties that are themselves relational and others which are not. The case of certain electromagnetic properties is the clearest example of this. Let us look at this in some detail, as it is a good example of how our commonly used anthropocentric viewpoints can mislead us and also how to progress beyond them. It will also lead directly into a discussion (later, in sections three and four of this chapter) about events and relativistic properties.

It might appear from our perspective that electricity and magnetism are ontically disjoint. After all, an electric field near a compass does not cause the compass needle to spin, and a magnetic field by itself does not seem to store energy in a capacitor. But, a time varying electric field induces a magnetic field and conversely.

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$$
$$c^2 \nabla \times \vec{B} = \frac{\vec{j}}{\epsilon_0} + \frac{\partial \vec{E}}{\partial t}$$

Figure 4.1.1: Two of Maxwell's equations.

The first equation asserts (with the ordinary correspondence rules³⁴) that a time varying magnetic field induces an

³³ Strictly speaking, the law statements in which they occur are said to be invariant, however, physicists often speak as if it were the properties in question referred to in the law statements which are such. After all, the law statement represents one kind of property - a law.

³⁴ For those readers who are not familiar with the ordinary correspondence rules, they are: \vec{E} is the electric field intensity, \vec{B} the magnetic field intensity, c is the speed of light, \vec{j} is the current density and ϵ_0 is the permittivity of free space (a constant).

electric field and the second the converse. The properties involved are (the electric charge distribution) thus different but connected. (Note that they are connected through the notion of a current density, as the pretheoretic observation that a current carrying wire has an associated magnetic field suggests.)

Because of this connection, we can thus say appropriately when an electric event is identical to a magnetic event for two distinct reasons. One is because they are dependent on each other in a sort of "spiral" effect, the second because the properties involved are invariant. It is only in the dynamic case that this is true³⁵. If there is no changing magnetic field, the right hand side term of the first equation is just zero and that of the second just $\frac{\vec{j}}{\epsilon_0}$. Thus in

the limit of no temporal changes to the appropriate fields, electric and magnetic events can be distinct. If one did not know the deeper connection between the two one might mistakenly regard these events as distinct. Our representing our knowledge in ordinary terms ("electric", "magnetic") might have led us astray. This suggests that the degree of analysis of properties affects what we know about the distinction of events. This of course does not entail that events are themselves fuzzy or indeterminate, just that our knowledge of them can be incomplete.

As I have said, qualitative/quantitative is another I must elucidate for this thesis. Qualitative properties are ones which do not have degrees or magnitudes; quantitative ones do. It seems as if (save for existence) there are no intrinsically qualitative properties. Not knowing any way to defend this, I shall leave this issue open, and develop (section three) an account of properties that is relativistically consistent but does not commit on either side of the issue. This is important, since if there are some other intrinsically qualitative properties, we require a

³⁵ Recall, however, that the dynamic case occurs "very often." See figure 3.2.1 in chapter three, section four for an illustration why.

notion of a proper property (one the same in all inertial frames³⁶) to relativize them correctly. All known invariants in science are quantitative, again perhaps save existence. More on this in section three, below.

My next area of discussion concerns whether properties should be considered universals, particulars, tropes, or of some other category. For the purposes of this thesis, this decision need not be made, except for one detail. This one detail is that the account of properties has to allow them to undergo change - one property has to be capable of passing away, and another coming to be (if there is any difference between these two I shall remain agnostic) and a property has to be capable of increasing or decreasing in magnitude.

Four other features of properties must be adopted to round out this account of events. First, things (and perhaps objects generally) have essential properties. Here, I refer to a weak sort of essentialism. Any property whose loss or gain alters the "kind" of a thing is an essential property. A helium atom has the essential property of being atomic number 2, i.e., it has 2 protons essentially. If it gains a proton, it is no longer a helium atom, but a lithium atom. If it loses a proton, it is no longer helium but hydrogen. These atomic species are physical **and** chemical kinds.

Second, conservation laws are significant to my account because they provide constraints upon the range of possible property changes involved in events; and in closed systems they have the bonus effect of ontically "isolating" that which is undergoing the event. If we can determine that energy (say) is conserved in a given region, we can thus rule out the rest of the universe as irrelevant to the consideration of the event in question. To this end, the properties in the known conservation laws are of fundamental importance, at least epistemologically speaking.

³⁶ As noted in chapter one, this thesis does not concern itself with accelerated frames of reference.

Ontologically, conservation laws perhaps "carve the world up at its joints," as they affect to some degree where one thing or system stops and another begins. Note that any of the conservation laws can make due for these purposes; which one to use is case dependent. Also, note that this makes implicit use of what Feynman et al (1963, vol II, pp. 27-1 ff.) call local conservation laws, as it is conceivably possible that the universe could operate under global ones. Only local ones are consistent with relativity, so this locality constraint on properties is one way of insuring the required relativistic consistency. This finite speed of propagation of influence is in turn what "carves the world." Upshot: with this, one has another means of overcoming worries that all events in the universe are one. It gives some sense to the notion of "minimal subject" of an event I shall use later.

A third general note on properties is in order. Readers of Kim (1993) will recall that he makes a distinction between the properties involved in an event and the properties of the event itself. Events are objects (see the first appendix for my usage of "object") and thus have properties. These properties are of a different sort than the properties that are involved in undergoing many events. This leaves open the question of higher order properties as well. Are the properties of events themselves properties of the properties that are "involved in the change"? It appears so thus, it is fair to say that this account of events requires at least second order properties. But does it require third order properties (and so on, ad infinitum)? It has been argued (in, e.g., Armstrong 1989) that an infinite hierarchy of properties is undesirable. However, the current theory of events requires only at most a potential infinity, not an actual one (or, if preferred, a finite but unbounded) regress of properties. An actual infinite-order event would seem to require that an infinite number of properties change at once, which seems unlikely.

Fourth, Auyang (1995, pp. 129 and elsewhere) reminds us that properties as understood in QFT (and hence SR) are often

properties of fields. It is commonly understood that fields allow little individuation of their parts, and thus, localization of their properties is difficult. Auyang thus suggests that some properties may be "spread across" an amorphous object like a field. This is important as the postulate (adopted by Davidson and by me later) that spread out events are not only features of ontologically more complicated things.

The state of a system of fields is a summary of the properties of the entire system. On Auyang's (commonly accepted) assumption that fields are continuous, the system possesses the properties over a nondenumerable number of parts. Auyang's remarks serve to remind us that properties may be distributed over a large location, and thus, a single event can occur over a large spatial volume. The ontological complexity of an event bears no direct relationship to spatial size. This motivates (in part) my postulate that an event occurs at the spatiotemporal location in which the minimum subject of change occurs. More on minimality in section four, below.

Section 2 - Causation

In this section I address three issues surrounding causation: the nature of the relata of the causal relation, whether causation is proximate (and hence how events link to each other) and the relation of the "amount" of cause and effect.

To address the first issue, let us briefly investigate various kinds of causation proposed in the literature, keeping in mind Hitchcock's (2000) helpful suggestion that people use the word "causation" and its cognates in many different ways.

Some authors (e.g. Bennett 1988, ch. 3-4) distinguish event causation from fact causation; others (e.g. Ehring 1997, pp. 86 ff.) believe that properties (tropes) simpliciter are the relata of the causal relation. Many other positions exist. It seems likely that many forms of so called "fact causation"

are actually due to events occurring at another level. For instance, a condition like the weakness of a bridge referred to in "the weakness of the bridge caused it to collapse" is a condition on which a force (cause) like a twisting or a bending can act upon. (Recall also chapter three, section one's arguments against Sanford.)

I now turn to my second issue of this section. The current work adopts a thesis of weak proximate causation (i.e. causation through approximate contact). However, the current work does not commit to how proximate proximate is to be. Since all four fundamental forces in physics are actually contact forces (i.e. occur by things colliding with each other - see Hawking 1988, pp. 70-73 for a discussion of mediation of forces by particles), proximate should perhaps be "contact"; but this is merely a suggestion. It is, after all, conceptually possible that a non-contact species of force could emerge out of contact ones, though it is not immediately obvious how. But of course my imagination is no limitation on the functioning of the universe (except for the functioning of my imagination!) so this is hardly a worry. Events cannot themselves be widely separated on this account and still be "the same event," nor can they be individuated by events far apart from the event in question.

An example should pump the "implausibility intuition" I have in mind. For instance, on some accounts of causation, the Big Bang (among other events) caused my conception. It is possible that a hydrogen atom formed in the Big Bang is found in one of the cells that underwent my conception. However, that hydrogen atom hardly changed in properties relevant to the conception, and instead merely changed relationally. (For instance, it became near a whole bunch of different atoms.) Here is where the notion of emergent properties mentioned in section one of this chapter also plays a role. The conception instead involves emergent properties of ovum and spermatozoon, etc., not physical or chemical properties of hydrogen. This suggests that some events possibly emerge out of lower level events just as emergent properties emerge out

of lower level properties.

My third consideration for this section is to note that the above suggests another postulate (albeit a negative one) about causation I shall adopt. It was a principle of scholastic metaphysics that the effect is no greater than the cause. I deny this. An example shall make this clear. If I kiss Raven, she will become excited and use more energy than the tiny amount of kinetic and thermal energy I transfer to her in the kiss. This is a clear case where the effect (an exciting of Raven, to use the event description language) is greater than the cause (a kissing of Raven). Connected events thus need not be "similar" in the respect demanded by scholastic metaphysics; proximate-causation is only to be understood spatiotemporally, not propertywise. The question of how propertywise an effect is related to its causes is beyond the scope of this work. (There must be some connection on pain of denying the principle of lawfulness, though.) Note also that this suggests another way in which causation can be used to show that events are distinct (and do not collapse into long amorphous processes). This is because there (by the above) can be wildly unlike causes and effects, thus in some sense breaking the continuity between them.

Section 3 - Proper Property

This section concerns itself with the invariants mentioned in section one and argues that the notion of an invariant works only in the case of quantifiable properties. Since whether a predicate (i.e. our linguistic or mathematical representation of a property) is "numeric" or not depends on our state of knowledge about the world and not about the world directly (Bunge 1998, vol II, pp. 227-228) whether a property is intrinsically qualitative is generally unknown. It thus bears elucidating a generalization of the notion of an invariant property that extends to qualitative properties. This is the goal of this section of the thesis.

An invariant partially works to solve the relativity of properties problem discussed above because it results in a

single value for the property in question across different frames of reference. Electric charge, as we have seen, is such an invariant; it has the same magnitude and sign in all frames. By examining (performing dimensional analysis on) the dimensions of a derived property (e.g.: lengths, masses, quantity of charge) we can thus work out whether any given property is invariant. However, this procedure presupposes that the dimensions of the property are known, which in turn presupposes and is presupposed by quantification of that property. Not all interesting properties have known quantified dimensions (particularly those in social and mixed science such as social cohesion, political stability, etc.). So we need to use something more general than an invariant. Instead, I suggest we use the proper property of something, which is defined as the value (qualitative or quantitative) of the property in the rest frame of the thing.

Thus, change in proper properties are events. Changes of properties relative to a frame of reference are not. Proper properties are also to be understood at the highest appropriate level. For instance if a property is physico-chemical (e.g. electronic configuration) the appropriate proper property of the object in question is to be understood chemically. (It is true that in most cases the previous concern will make no difference to the individuation of the events in question.)

By the above, mere unaccelerated change in position of a thing is not an event (as its velocity is always relative to that of another frame - it is zero in its rest frame.) It must be noted; however, that any thing coming to have a new velocity must be accelerated (by definition), and this acceleration is an event. But, once velocity is again constant (i.e. the force is no longer acting) and inertia "takes over," qua movement the thing is no longer undergoing any events. It may very well be undergoing events of other sorts. Also, note that sometimes it is unclear when an acceleration actually occurs. If Robin drives me from her apartment to my parents house, while we are moving straight

and she doesn't hit the gas or the brakes, we undergo no movement events from the car. However, we are constantly undergoing gravitational events - the acceleration downwards towards the earth. (That this might be also one protracted event need not concern us for the moment.) Every time we turn a corner, or slow down, we then undergo an event.

Proper properties are thus those that undergo changes in genuinely causal interactions. Note that in the case of uncaused events, the causal interaction is "within the thing itself." For instance, in the case of a radioactive decay, the atom decaying "produces" the cause. When we say that radioactive decay is uncaused, it is meant that the (perhaps probabilistic) internal forces are involved (e.g. the strong nuclear force). Here again an appeal to emergent properties explains these facts.

We have now met the completed understanding of properties needed for the special theory of events. I turn to this central part of the thesis now.

Section 4 - Axioms for the Special Theory of Events

We have met earlier (chapter three, section four) an account of events that is more or less satisfactory except for its lack of relativistic consistency. Earlier sections of this chapter have developed understandings of properties and causation that are necessary for relativistic consistency. These two investigations (properties, events specifically) are joined together in the new theory of event individuation which follows. I present 9 axioms for this new theory. Each of these shall be indicated with a bold numeral in parentheses: **(n)**. These shall be followed by several applications in both science and metaphysics.

The central postulate of this new theory:

(1) Events can be described qua "happenings" (i.e. in terms of other events) or qua property changes.

Thus, an event can be represented as a 7-tuple:

(1a) $\langle \Delta x, \Delta y, \Delta z, \Delta t, F, C, E \rangle$

or a 7-tuple:

(1b) $\langle \Delta x, \Delta y, \Delta z, \Delta t, F, P_1, P_2 \rangle$

In (1a, 1b) $\Delta x, \Delta y, \Delta z$ are spatial intervals, Δt is a duration, F is an (inertial) reference frame, C and E are sets of other events - causes and effects of the event in question - presently, either of which may be empty. P_1 and P_2 are collections of proper properties (as above). These properties are to be understood as the event's change; by convention P_1 is the initial state, P_2 the final. The time variable (Δt) here represents the time (in frame F) that the thing takes to go from P_1 to P_2 , or the time of occurrence of the event. Because of the use of proper properties the reference frame is only required to specify the spatiotemporal interval of the event. Ontologically, then events are changes in property exemplifications (sometimes) brought out by events in other things and resulting in further events. This then is my principle of individuation for events.

Why are both (1a) and (1b) always applicable? Consider first (1b). Genuine changes occur in the world. These are events by definition. But what do changes do; how are they connected to one another? They produce other changes. I take this as a fact well known to common experience and to science and technology. Thus events essentially have effects, which are other events. Do they have causes? Well, many of them do - many changes are induced by other changes, as we have just seen. But some appear to be induced by spontaneous processes acausally. Thus when I postulate that an event can be described in terms of its cause and its effect, the cause in question may very well be null. (See postulate (5) below.) (1a) in turn suggests (1b) because a cause and effect are always events themselves. But an event is a change in properties (as I remarked in section three of this chapter). This shows that both (1a) and (1b) are ontologically sufficient. They are both ontologically necessary as (1a) individuates events "from the outside" and (1b) from the

inside. This is somewhat parallel to looking at a thing as being individuated either by its internal properties or by the totality of its environment.

Thus (1a) and (1b) are always both applicable ontologically. Then a motivational question remains - can one use either one to describe and avoid Davidson's regress problem (section three of chapter three)? Certainly. Should we wish to stop the regress of individuating events by their causes and effects, we simply make use of a description of the form (1b). Since (1b) relies on us having non-causal individuation criteria for properties (see chapter three, section three), this breaks the regress.

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The preceding considerations suffice to individuate an event of minimal temporal size. But for larger events, the notion that they involve a change in state runs into problems much like those raised in Davidson's criticism of von Wright, considered in chapter two, section two. Von Wright had suggested that an event is representable as an ordered pair <initial state, final state>. This resembles my (1b) with its P₁, P₂ components. Davidson claimed that von Wright's proposal would not do to individuate large events such as those referenced by "I flew from Pittsburgh to San Francisco" as this does not say enough about how the event occurred. However, a slight addition to my account can accommodate this charge. This is merely the intuition that larger, more "process like" events are the temporal sum of many smaller events. We have met this idea before in my discussion of

hydrogenation reactions earlier in chapter three, section one. Hence, we may postulate that in the case of larger events they are composed out of smaller ones and individuatable somewhat "recursively." This can be stated as:

(1c) Temporally extended events are composed out of events with smaller temporal extension. This bottoms out at whatever is the minimal event in a given context.

This theory of events does not committ to the view (or the contrary) that all events bottom out at the same degree of minimality (e.g. whether all events are composed out of microphysical events or not, etc.)

We hence can conclude that larger events are individuated (also) by their unique parts. For instance, two of Davidson's possible trips from Pittsburgh to San Francisco are decomposable as in turn (e.g.): (a) getting in the taxi, driving to the airport, waiting in the check-in line, boarding the plane, etc. and (b) putting on his good walking shoes, walking from Pittsburgh to Chicago, walking from Chicago to Kansas City, etc. Note that each of these subevents can in turn be decomposed, as required. For example, (a)'s first subevent can be composed of various leg flexions and extensions and so on. These two "trip" events are different because their compositions are different, even if they were hypothesized to take place at the same time and place and involve the same causes and effects.

Since a process (extended event) can occur in different orders relative to a given frame of reference, it is important to remember that events are individuated in their rest frame (as (1b) should remind us as it involves proper properties). This brings us to a consideration of my postulate concerning the spatiotemporal location of an event.

(2) The spatiotemporal location ($\Delta x, \Delta y, \Delta z, \Delta t$) is the minimum subject of what is either affected by the cause (i.e. an object or a proper part of one) or which undergoes the

proper property changes in question (in (1a), (1b) respectively).

Were they to be maximal, all events in the universe would be the same event. (Conceivably, the entire, even if infinite, history of the universe could be regarded as one long event, though see above in section two for how implausible this view is. See also the last part of this section for remarks on the event/process distinction.) There is also no sufficient reason to adopt anything between minimal and maximal. That we may not know what the minimal subjects of an event are and are thus often mistaken about them is no objection as events have minimal subjects ontologically not epistemologically. Note also that there is in general no connection between the ontological basicness of an event and its size. As remarked above in section one, events in quantum field theory can be spread over a large area, and yet these are among the most ontologically basic events known. This minimal interval should be that in an appropriate frame of reference, F.

I have noted earlier that (unaccelerated - as this is a special theory) events have a rest frame. This means since a rest frame is a worldline, not a single point, the rest frame of the objects undergoing an event is that of the point of transfer of influence which has its own worldline. Recall that I postulated that all forces are contact forces in section two above. The frame where the objects which are undergoing the event are moving with zero velocity is the rest frame of the event; as I have stated this is where the event occurs for purposes of individuation. For instance, in the case of an object undergoing a self induced change (e.g. radioactive decay) the rest frame of the event is just the rest frame of the object. See below for responses to possible objections to this based on EPR correlations. Note this consideration is in line with treating events as factual objects. This concern shall come up later in postulate (9).

I shall now introduce two postulates which concern two species of mereology of events. These two species are

"temporal" and "spatial," which are illustrated below.

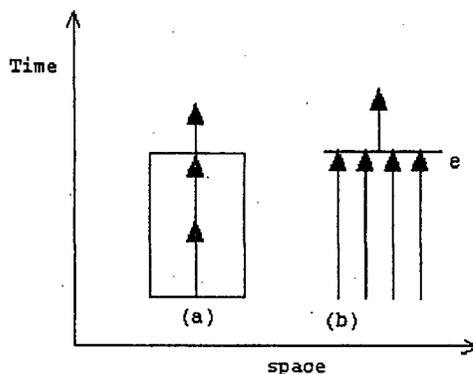


Figure 4.4.1: Kinds of Event Mereology

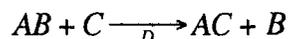
As mereology in general is off the subject of this thesis, these shall only touch on this issue as it affects the criteria of individuation I have postulated in the previous axioms. I shall begin with a minor assumption that is relatively straightforward.

Lemma: The number of events in a given spatiotemporal region (relative to the appropriate frame F) is greater than or equal to zero.

We have previously met Davidson's arguments (chapter 2, section 2) for allowing more than one event in a given spatiotemporal region. It should be obvious that there can be (however short lived) locations where no events take place. We can thus state (3):

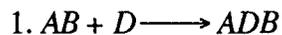
(3) Events can combine along the temporal dimension in F to form larger, extended events.

This postulate is illustrated in (a) of the previous figure. I have noted earlier in (1c) that this postulate allows individuating extended events. Let us here rehearse a scientific illustration of temporally composed events. Consider again a catalyzed chemical reaction:



Reactions of this form might take place in two steps. For

instance one possibility is:



The first stage of the reaction and the second stage of the reaction combine to form an overall reaction. Each stage is an event; the larger reaction is also an event. This postulate (with some isolation from outside events) insures that this account of events permits what are commonly called processes.

Isolation prevents mereological composition and thus avoids making the universe into a single event. This result is to be avoided for several reasons. First, a universal event would suggest an exception to axiom (6). This axiom is the postulate that all events have an effect.

What could be the effect of the universal event, especially if this event has no end for which an event could occur after? Second, my understanding postulates in section two above that causes are like their effects - by the equivalence in axiom (1) this suggests a connection of some kind between the collections of properties involved in an event. The universe has nothing (by definition) out of which it can be produced. Note that I am using "universe" in its broad sense - i.e., as "everything that exists," (taken tenselessly) not its narrow sense sometimes used in physics as something like "isolated spacetime region." (See, e.g., Stenger 2000a for this latter sense of universe.)

Also note, I reject mereologies that allow disjoint objects to form mereological sums. The reason for this rejection is my prior assumption that the events which occur are lawful (i.e. are nonmiraculous, and "obey" basic laws of conservation). As I have stated, there is a connection between the properties which undergo a change in an event. Unrestricted mereological composition (at least in the temporal sense) would make these connections unlawful. For instance, there is no extended event ("process") that connects my putting on a t-shirt with what I had for breakfast. There are psychological events within me during

the intervening time, but they are (presumably) unconnected.

Note that this isolation should be understood at an appropriate level of reality to the events under consideration. Physical events likely do not fuse with sociological ones very often, so considering the changes in conformation in someone's protein molecules as the person forms part of a group of students debating mechanism in Aristotle is unlikely to be helpful. Ontologically the physical and social levels in this example are far enough apart that the two do not act on one another. This brings us to the second of the mereological postulates.

(4) Events which are in close spatiotemporal proximity can combine to form larger events.

This postulate (illustrated in (b) of figure 4.4.1) is to be understood as relativistically sound. Events which are not "sufficiently local" cannot mereologically combine except where they are close to each other. For instance, light can propagate from two distant stars and strike my eyes combining to produce some psychological event in me. A mereological combination (two strikings, for instance) because they have come together in one location (my retina, say). This is why it is important to remember that the emission of the light is a different event from the striking of the retina. The former is the cause of the later, or perhaps a cause.

However, it stands to reason that the properties of the events that mereologically combine are related in some way.

For instance, a brushing of a toothbrush and a flowing of water might combine to form a toothcleaning. These are able to combine because they both change the composition of the materials on one's teeth. A general theory of how properties are interlated is beyond the scope of this work. Hence, providing any additional details of the spatial mereology of events is beyond the scope of this work. Since this consideration does not affect their ontological individuation

(though it likely affects their epistemological individuation), I leave this for future work. I have intuitions about the spatiotemporal proximity and property connections necessary for spatial event summation as seen by the two examples; I do not see any way to refine these at this time. Thus, the theory of events proposed in this work simply takes the possibility of spatially summed events as given.

Also, note that axioms (3) and (4) likely never "apply" alone. Temporally fused events ("processes") are likely very often have subevents which are spatial sums of events and conversely.

Finally, note that the mereological postulates ontologically ground the fact that the number of events counted in a given region often depends how they are counted. If two things near each other move from state A to state B, there are two events if the changes in question are "unrelated." If the changes are related, one counts three events. On the other hand, if some investigator was unconcerned with lower level changes, she might count one event.

On to the next postulate, then.

It is important to consider whether either of the "cause set" or the "effect set" may be empty. Ontologically this corresponds to the case of an event having no cause and no effect, respectively. Because of apparently well-established scientific results (e.g. quantum fluctuations) I postulate that:

(5) Events can occur without cause.

An effectless event is less likely. They would be somewhat irrelevant if they did occur, as one could never know that they had happened or come to be affected by their influence. I postulate, therefore, that:

(6) There are no effectless events.

I adopt this hypothesis as such an event would be scientifically illegitimate as any hypothesis about it would be untestable. This postulate also has the metascientific consequence of encouraging research into the effect of events. For instance, Hawking (1988, pp. 103-104) considered the case of information loss in black holes. This case works as follows: Hawking wondered what happens when something "falls down" a black hole. Does this have any other outside consequence, or do (because signals cannot escape the black hole) any possible events within the black hole have no effect on the outside universe? This latter possibility was (for whatever reason) displeasing to him, and so he investigated the matter. This led him to derive the hypothesis that the surface area (an external, accessible property) of a black hole is proportional to its entropy, an internal property (hence directly inaccessible). In short, my postulate has already proved useful scientifically! (Recall also the arguments against Lombard in chapter three, section two which use conservation laws.)

(7) Some of the features by which we describe events (causally or otherwise) are not strictly speaking those properties involved in the event proper but boundary conditions.

For instance, "The rigidity of the balloon caused it to burst." Assume that this occurred when someone was blowing into it to fill it with air in preparation for a party. Strictly speaking, on this account, the blowing (as that was an event) caused the bursting (or, in the property language one can appeal to changes in volumes of air etc.). The boundary conditions here are the flexibility properties of the balloon. This postulate serves to remind us that not all properties referred to in a given event statement need be the properties actually those involved in the change that is the given event referred to and hence against a particular naive realism.

I have now introduced 7 primary postulates of the new theory. Let me now look at two remaining postulates concerning the 7-tuples as a whole. The first of these postulates concerns the emergence (or some might say supervenience of) events out of things. The current account of events, like Davidson's or Kim's, has events emerge out of properties, things and their changes.

Are things on this conception "basic"? Here, we must see why events are not basic objects in the universe (pace, e.g., Whitehead 1929). The reason for this is quite simple. I assert that events are all of something as factual properties are always of something. The argument that because things are possibly always in flux does not show that "event" is ontologically basic.

It is also important to realize that the disjunctive description of events presented (either this 7-tuple or that one) is not intended to mirror nature. Both are alternative ways of expressing the same underlying reality. After all, tuples and disjunctions are logical and semantic features of our language, not parts of the world. We thus have two mutually complementary descriptions of every event. Which one "really describes" the event?

(8) Both (1a) and (1b) "really describe" the event taken together.

A change in properties is what happens in the event; the causes and effects of this situate the event in the "network of becoming." See more in the discussion of (1) above for why one can make use of either description.

Some philosophers may wonder what sort of metaphysical category (universals, particulars, tropes, etc.) this theory puts events into.

(9) Events are concrete, unrepeatable particulars.

Davidson's arguments for these views still hold (see chapter two, section two). This is not to say that events cannot be placed in classes; such is indispensable for science. Since any event can be looked at "cause and effectwise" or "property exemplificationwise," scientists and philosophers are free to use either sort of classification. For example, if tropes are understood merely as that red or that charge density, then an event can be understood as a change in trope(s).

Events are thus not repeatable any more than things are. All electrons are interchangeable (i.e., speaking didactically, if one were to exchange the electron in a hydrogen atom with another from a second hydrogen atom with its electron in the same energy level, nothing would happen) but they are not identical since they are in different spatiotemporal locations - similarly for events. Many events (at least at the physical level) are interchangeable as well, but they are also not thereby identical.

Now that we have seen the nine principle postulates for this new theory of events, I shall close this section by considering a few representative examples and applications.

Let us examine one of our vexing cases of identity we have discussed previously - investigating when a given electric event is identical to a given magnetic event. With the above conceptions of properties and causation and how they relate to events on the table, the solution is almost trivial. Compare the appropriate properties involved (e.g. the field strengths) and the degrees of causal influence (magnitude of the forces involved, as physicists would say) by transforming them to the same (any one desired) frame of reference using the Lorentz transformation. Are they equal in all components? (I.e., did the same properties change?) If yes, then the events are identical. If not, they are not. This option is not open to Davidson as transforming merely spatiotemporal location (e.g. by the Lorentz transformation) or merely cause would fail to identify the events correctly. As Davidson

himself points out, this criterion can fail if there are two events in one place and time. The property changes which the thing undergoes at this place and time are thus what "saves the day." Using the Lorentz transformation on the expression for the strength of the electric and magnetic fields yields (assuming that the frame is moving in the positive x direction with velocity v way from the electric and magnetic fields in a frame at the origin):

$$\begin{aligned}
 E'_\parallel &= E \\
 B'_\parallel &= B \\
 E'_\perp &= \frac{(\vec{E} + \vec{v} \times \vec{B})_\perp}{\sqrt{1 - v^2/c^2}} \\
 B'_\perp &= \frac{(\vec{B} - \frac{\vec{v} \times \vec{E}}{c^2})_\perp}{\sqrt{1 - v^2/c^2}}
 \end{aligned}$$

Figure 4.4.2 E&M and the Lorentz transformation.

The above shows that the electric and magnetic fields in another frame of reference can be easily computed. And then from these the force can be calculated using the Lorentz force equation. But, note that one needs the field strengths from the above equations first. We cannot identify causes and effects without knowing what "makes them up," i.e., what properties are involved. This explains my adoption of properties as well as causation in my principle of individuation for events.

The previous approach is very similar to those of Auyang (1995) and Bartels (1999 [1998]). Since an explicit goal of each of the two previous works is to connect the metaphysics events to quantum field theory, they are thus doing a similar task as the present work and thus bear investigation for that reason. Let us first see what Auyang has to say concerning what events are like and how they are individuated. She writes (1995, pp. 129):

"An event is a dynamical quantity; it is the transformation of the state of the field system at a certain point. For example, the event $y_i(x)$ may represent

the excitation of certain modes of type i [...]"

In other words, Auyang suggests that when a field system undergoes a change in state, this is an event. This is in line with the current theory's recognition that events are changes in properties. Since Auyang's events are pointlike, a dense continuum (assuming fields are continuous things) of them producing evolution of the field system in a specific way results in the persistence of a thing and how "microevents" aggregate to form events in the metaphysical (or every day) sense. As such, she recognizes that if one regards things as ontologically prior to events (as one should - see above concerning Whitehead) then her events are "mere instances" (her phrase), and they need to be aggregated to form events in the ordinary sense. It is not clear how this aggregation is to be understood. Epistemologically one represents the instants as products over a space of field operators (e.g., if the event occurs all with excitation mode i and e is the "total excitation"): $e = \prod \psi_i(x)$.

This suggests that spatiotemporal juxtaposition could allow Auyang to elucidate more familiar sort of events. However to do this, some account of the properties that emerge from this mereological sum must be indicated. I regard Auyang's conception of events as thus incomplete if viewed as a general conception, however, it fits with the current account of properties and their connection to events as far as it goes in QFT. The special theory of events of the current work is more general than Auyang's not only because it admits properties at higher levels of reality than those described by QFT but because it is stated in non quantitative terms: in order for the above product to make sense the properties have to be "multipliable" in some sense.

Bartels (1999 [1998]) has responded to the Auyangian conception of events. He argues that events as understood in QFT are not merely state changes but instead closer to Davidson's conception of events. Bartels' principle argument is more convincing especially if one builds into a

Davidsonian conception of events (i.e. one involving causation) some account of properties, as I have done above. He writes (pp. 182):

"The following consideration suggests that this is the case: In a high energy experiment a particle decays in a detector. The identification of the products of the decay enables the experimenter to identify the original particle state. Its future causal history is used as a means to individuate the state. The original particle state has been of such a type that it causes decay products of that particular sort. What is more, it has been a particular instantiation of the particular type of state that has decayed precisely at the particular spacetime point³⁷."

Bartels is thus suggesting that the notion of what happens to particles and detecting their kind involves discovering what effects they have on other things. This is Davidsonian as further events are used as indicators of the occurrence of a previous one. But, note we need some understanding of properties (for instance, the energy levels of an atom) to make use of Bartels' suggestions as otherwise, we get stuck in the regress that vexed us earlier.

Thus, according to my theory of events, Bartels and Auyang are both (partially) correct. Since change in properties is "part" of what is involved in an event, Auyang is certainly correct to point out that a changing excitation state of a field is an event. In turn, Bartels is right to point out that causation can be used to elucidate the roles of objects in a quantum system. This can be stated thus: excitations of fields are the fundamental events in QFT. Which excitations and how they "work" is not my concern, nor is it Auyang's in the passage provided. It is hence not at all surprising that she would characterize these in general terms. (Recall the discussion of classes of events vs. particular events above.)

My final scientific application is to the so called EPR paradox. Do the distant correlations observed in the Aspect experiment involve events? Yes and no. Yes, because the

³⁷ For "point" here one should read interval; nothing in QFT requires particles to be point-like (nor does it rule out point-like ones, like the electron is sometimes thought to be).

observation involves events. But, the correlations themselves (which exist independently of observations) are not events, as they are purely relational connections. There is no transfer of influence involved at all (Stenger 1995).

A (somewhat misleading for it is not a quantum level case) thought-experiment/analogy will make this point clearer. Take a deck of playing cards and shuffle the deck well. Now take a card at random and cut it in half without looking at it. Seal one half of the card (still without looking) in an envelope and send that to a friend far away. Do the same with the other half and another friend also far away (preferably also far from the first friend). After a few weeks or months, when your friends have received the mysterious envelopes, call one of them by phone and ask what half card they have. Instantly you know what half card your other friend has, thus "collapsing the [description of the] card"³⁸. No causal influence passes from your called friend to your other one.

Events which are involved in this are the shuffling, the selecting, the cutting, the sealing, the mailing, the receiving and the calling by telephone. (This is not meant to be exhaustive.) The purely epistemic change in you when your friend says "yes, four of clubs" is a (series of) brain event(s) (presumably) but that is not the correlation between the cards. Similarly, because one "tangles up" the (e.g.) photons in the EPR experiment, of course they will be connected in some way. (For another, "state oriented", non-causal and hence no-event³⁹ explanation of the EPR correlations see Stenger 2000, pp. 190-1.)

³⁸ By analogy, the wave function is not a real thing either (nor does it have a direct referent), it is "merely" part of a (sophisticated, mathematicized) description.

³⁹ This is what the appeal to properties above is supposed to demonstrate. If there are no properties being influenced which are involved in the "connection", then there is no event. This analysis also presupposes that the subjectivist interpretations of quantum mechanics are wrong. Stenger (1995) also argues against this - I do not have the time to here.

The details of this section begin to develop a picture of part of the world. But, no picture of the world is without its critics, which brings us to the next and final section of this chapter.

Section 5 - Response to Criticism

In this section, I shall respond to possible criticism from six quarters. First, I shall answer a Kimian worry. Second, I shall deal with an objection concerning the understanding of space and time that is required in this theory. Third, I shall argue briefly against a naive scientific critic's possible argument that the metaphysics developed throughout this work does not help her solve any scientific problems and is thus irrelevant to scientific research. (This continues a thread from chapter 1.) Fourth, I discuss objections to the postulated equivalence between the two forms of event descriptions. Fifth, I shall take a possible objection from what might be called an "antiHeraclitean". Finally, I shall answer another science-inspired objection concerning the nature of forces.

I start with those objections I would expect from Kim. One such worry, about possibly static events has been dealt with elsewhere (chapter 3, section 2). However, another possible point of disagreement between Kim's account of events and the current one concerns the issue of properties of events themselves. I have argued that in order that merely relational changes not be regarded as events in order that spatiotemporal location not be regarded as amongst the properties of an event. Kim wants it that the event described by "Brutus stabbing Caesar" has the property of being in Rome (1993, pp. 42-43). Does this account thereby reject this attribution? No. "Rome" is a spatiotemporal property of the event, but it is not one that is involved in the change in question. Events are objects, and so they have properties of their own as well.

Caesar being stabbed is thus not relational. Relativity theories in physics make the velocity of an object dependent

on the frame of reference. But, these features are not other objects, but instead are just relations to other objects (i.e. "Cambridge changes" in the traditional philosophical jargon.) This is why I rule out merely relational changes. When we say that "Brutus was involved in a stabbing in Rome," we identify location just as we do in saying "the body at the end of spring S moved from position x_0 to x_n in time interval Δt ."

I shall move along to the third objection to my theory, then. Substantivist worries might be raised about my use of space and time to individuate events. On this account, to identify events requires "the use of" spatiotemporal intervals. Does this account thereby commit one to them existing in some sense? No. They are not to be regarded as things or occurrences, merely relations between things. They can even be regarded as "useful fictions" if necessary, for instance, if the speculations of Barbour (1999) or Stenger (2000) turn out to be correct and the passage (or "direction") of time is in some sense illusory. If either of these two hypotheses is correct, time indexes would still be useful. A slightly misleading analogy will make this point.

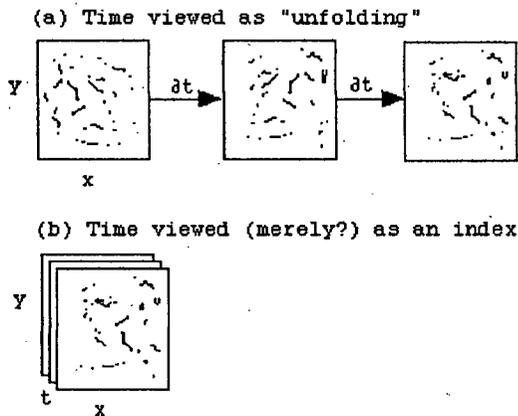


Figure 4.5.1: Indexing.

In the above figure, (a) illustrates the "becoming" view of time. The (b) part of the figure shows how in the "timeless" (Stenger's term) or "illusory" (Barbour's) view of time is understood as "merely" another coordinate, perfectly on par with space. (This is roughly similar to the Minkowski view of

spacetime (McCall 1994, pp. 10).) Note how the stack of slices becomes cubic⁴⁰. In actuality, cubes stack to form a tesseract (or generally 3 dimensional things aggregate to form "hyperthings"), but the principle is the same. We can thus "count slices" away from a given origin (in either direction, in principle) to locate an event (or the things undergoing it) on the time axis. Each event thus still has a unique location in spacetime. Only the becoming aspect of time is discarded. There would still be patterns in the four-space, which we would call "events."

The fourth argument to consider is an imagined one from a practicing scientist. She tells me that the metaphysics I have developed here does not help her solve any scientific problems, and thus (while perhaps intellectually interesting in its own right) it does not meet the metascientific goals I discussed earlier in chapter one.

To respond, I would note four things. First, it is not quite true that this account of events has no scientific importance. It provides one way of looking at the EPR paradox - which is important to some physicists. Second, it is not my job (at least here) to apply the theory of events. Understanding the way the world unfolds generally might prove useful as a framework in many sciences. Specifically, this theory of events reinforces the fruitlessness of searching for effectless events without committing one to verificationism. Third, scientists (such as Auyang) have found it fruitful to understand what the world must be like in order that their science is possible. Examining presuppositions is the aim here. I have tried to elucidate some of the presuppositions used in scientific research - laid them bare so that they are up for scrutiny just like other aspects and methods of science. If it turns out that my account does not reflect scientific research in content, it behooves someone else to refine or expand it accordingly. As

⁴⁰ The figure depicts the world as having a discrete time axis. This is not an essential feature of this view of events or times, nor is the contrary. It is simply easier to draw that way.

Bunge remarked once (1999b) - to paraphrase: "If you agree with everything I say, you have not been paying attention!" But, objecting to it merely on the grounds it appears useless is not legitimate. The fourth and final response is to ask the scientific critic to look at what has been proposed and not merely read off what it is about. Then deciding that they could use such a framework can hopefully be made without prejudice. (I only include this objection and its answers because the objection has been made to me, and I have hence responded.)

I shall now address a fifth possible concern about this theory of events. I postulated that it is always possible to interconvert between a "cause and effect" description of an event and a "property change" description of an event. A critic may still be asking: "what if this is not always possible?" I assert in response that anything that we would want to call an event by the rest of the schema is describable either way, has both "cause and effect features" and "property change features." Anything that does not is simply not an event. It may be argued that I am merely stipulating a word usage and not promoting a metaphysical hypothesis. This is in some sense correct, but the other characteristics of events I have described in the *Special Davidsonian Theory of Events* are not part of a definition but instead the "earmarks" of events. I have avoided defining event, leaving it implicitly defined, though chapter one's intuitive stagesetting is also meant to suggest and bring out features of the concept I am developing.

Should it turn out, after all of that, there is something that is clearly "of the right kind," is not described elliptically, and yet can be shown that it cannot be described in the two ways (for instance, an object that can be described in only one of the two ways seems to be a plausible candidate), I shall consider that a falsification of the views presented herein. Note that a mere inability to redescribe is not sufficient, as I (or anyone defending my view) may simply not be clever enough to do so. I regard the

possibility of this falsification as very slight as I have no idea how such a proof of impossibility would go. Note that this (and various other principles adopted) makes this theory of events weakly falsifiable. Since one complaint from scientists (and Popperians) about much metaphysics is that it is not falsifiable, this answer also speaks to the fourth worry above.

The sixth possible criticism I would like to handle here comes from what might be called an antiHeraclitean. I have mentioned that one event causes another in close spatiotemporal proximity and that all events have effects, i.e., they produce further events. Since nothing apparently would stop this proliferation of constant changes, this would seem to entail that this view commits us to believing that all aspects of the universe are constantly in flux. Since we know that is false (or epistemically undesirable, in a milder version of the objection), doesn't this render the view of events herein somewhat problematic?

The objection presupposes that the current theory of events entails that everything is in flux in every respect continually. This is false - when an event causes another in this scheme it sets off some change in another thing. Sometimes this may radically change the other thing, so that the resulting events (the effects) are throughout the thing which undergoes them.

But, this is not by any means the case generally. For example, in the chemical reaction symbolized below, the alkane groups in the cyclohexene do not undergo any chemical change, although the molecule as a whole becomes a new chemical species.

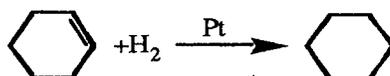


Figure 4.5.2: Hydrogenation of cyclohexene

Note how much of the structure is preserved through the reaction. The relevant (chemical) event (the hydrogenation)

only occurs in one part of the carbon-carbon ring. Of course, during the transition states in the reaction, the ring structure gets deformed (etc.). However, generalizing this to all hydrogenations of alkene rings, the larger the ring the more it is "intact" during the transition. This is not to say that there aren't other events going on in the rest of the ring; however, the "flux" of something is related to what scope of analysis is relevant. The physical level's own flux is minor compared to the chemical flux, which itself is not total - as indicated by the ring remaining intact. It may be that each thing is continually in flux in some respect or other, however. This I do not regard as an unfortunate consequence, if indeed it is one, of my theory.

The seventh objection is really a family of objections concerning forces, potentials, and the nature of causation in physics. The first of these can be phrased as follows: I have stated that forces are causes, and causes are events. But, where is the "event" involved in (say) Newton's law or the Lorentz force equation? These appear to be static and not involve any kind of change at all.

The answer to this query relies on my remarks about proximate causation. Since I have postulated (on the grounds that modern physics supports this conception) that all fundamental forces are contact forces, we can thus say (e.g.) that the force on electron in an electric field which deflects it is a cause, and that cause is a collision event (of the electron with the field, or with a photon, perhaps). One of course should not understand this collision in a classical way - it would in this case require a quantum theory of collisions. But that is for physics to explore, not metaphysics.

The second of these objections concerns potentials and forces. It may be remarked (Blok 2000) that forces are no longer used much in physics and that most physicists like to think in terms of potential and potential difference instead. Hence, why am I using forces as a prime example of causation and further, using a force equation to motivate part of the

metaphysics? This objection I feel is misplaced, because it presupposes that the only use of a concept in physics is to enable a calculation. I grant that calculations are often easier in the "potential picture" but that does not entail that the potential picture is a more realistically correct understanding. Of course, this cuts both ways. However, since I have argued that forces do seem able to play a direct role in the nature of being and becoming, I argue that our concept of force is probably closer to what is "really out there" than that of potential. Naturally, I reject the positivist dictum that science should abjure talk of causes.

We have met the new theory of events and hopefully seen it defended successfully against possible criticism. The final chapter in this thesis is next, which deals with possible extensions of this account and areas of further research.

Chapter 5 - Future Directions

I take the preceding chapters of this thesis as having developed an account of the principles of ontological individuation for events that is consistent with special relativity. This chapter considers several future directions of research to develop further this theory.

An important generalization to consider is an extension into the domain of the general theory of relativity. I have dealt with the special theory of relativity alone in this thesis because I am unqualified to generalize it. I do not even know what modifications or extensions are necessary in this area, or indeed whether any are. Since GR (like SR before it) changes understandings of time, space and causation, it is entirely possible that these will affect understandings of the happenings which are events.

This is also connected intimately with the possibility of second order (and generally, higher order) events. I have postulated (chapter four, section four) that events involve changes in properties and noted that there can be higher order properties of objects. Can the properties that events have themselves undergo events? If Socrates is dying quickly, and then takes a partial hemlock antidote so that he is now dying slowly, did his dying undergo an event? How so? Why or why not? If there are second order events such as that, can these undergo events too? This too is connected to the general theory of relativity as GR deals with acceleration. We have dealt with basic cases of this, distinguishing it from the unchange of constant velocity motion, but more needs to be said, particularly in the light of the new understandings of forces (particularly that of gravitation) in GR. Higher order events may require different principles of individuation - i.e., they may be ontologically distinct from lower level events. I have thus avoided discussing them much.

The theory also needs further applications in other areas of science, particularly social and mixed sciences. I have given chemical and physical examples of events; biological ones are also sorely needed. Applications to technology are also needed; in fact the use of the account in computing is a possible future project of mine.

I briefly discussed the mereology of events throughout the thesis. Particularly, the horizontal/vertical subprocess distinction is the beginning of an important application of the work. However, much needs to be done in this area. Since there are some papers (e.g., Pianzi and Varzi 1996a, 1996b) on the subject of event composition, there is clearly some interest in this area. Perhaps someone will want to take up this account of events and develop a better mereology of events from it. It may be that my account cannot easily account for mereology for some reason, in which case the investigation will prove destructive. Either way, it is an area that must be explored further. That said, the following is a "taste" of what must be considered. Mereology of events has to work in two different respects, however, spatially and temporally. What happens when two regions undergoing a change are juxtaposed temporally or spatially? Temporally, I have suggested that this captures some of the notion of a process (provided the properties involved are "similar" in some relevant respect - what this is to be is another area to investigate). Spatially, one might think one gets a "larger" event. If Harvey and Kathy show up one nice summer day and "attach" their picnic to that of Robin and me, we get a larger picnicking. But, this example again makes use of similar properties involved. Could they were to show up and attach a frolicking in the grass? A campfire burning? And so on. The more the juxtaposed events seem different; the more we are inclined to say that they are two events which happen to be next to one another and thus do not combine. Another question that has to be answered in this context concerns overlap. We have seen that it is plausible to assert that events can overlap spatiotemporally. When do they combine to form a larger event and when do they overlap? I do not know

generally what to say - I do not think this problem has been satisfactorily worked out for things (consider cases of phase boundaries, azeotropes [is an azeotrope one thing or two?], and the like), never mind for events. It is possible that this problem arises out of our imperfect understanding about the minimal subject of a given event.

The sixth and seventh possible areas of future research concern causation. One important missing piece in this thesis concerns the nature of causation and contact. I have tentatively adopted on metascientific grounds linkages of contact between cause and effect. This needs further research as there are general problems in physics with contact forces. Explaining how a contact force can be attractive is among the most vexing of these problems metaphysically, though it is reasonably well understood from the perspective of physics (at least at what might be called after Feynman a narrow "shut up and calculate" level). Whether there is a tension here is precisely the problem. Another concerns the fact that some field strengths (which mediate forces) become infinite in the neighbourhood of certain particles (e.g. electrons); again, there are proposed solutions (sometimes involving what look like ad hoc mathematical tricks - see Bunge 1985, Stenger 2000), but no metaphysics. The second area to investigate would be to take Hitchcock's (2000) list of putative kinds of causation and see which fit "nicely" with this account. This would lead to a greater understanding of events as it may be still that causes and effects need not be events, in which case understanding events becomes considerably more complicated. Sanford's problem (chapter three, section one) would arise.

I have now discussed briefly several areas of future research that would extend this work. The remaining sections of the thesis are a glossary and a summary of the principles from section four of chapter four.

Appendix 1 - Glossary of Terms

The present thesis has been replete with both scientific and philosophical vocabulary, which are in turn idiosyncratic and specialized. I provide this short glossary to define briefly my uses of key words. Note: the very central concepts, "event," "property," "causation" are not defined except implicitly by their interrelated uses in the thesis. This is to avoid circularity and persuasive definitions. Nevertheless, discussions of these concepts are found throughout. A bold term in a definition indicates that the term is also defined elsewhere in this glossary.

Absolute/Relational: A property magnitude is absolute if it occurs in all frames of reference. A relational property is one that is dependent on other properties and things for its value. For instance, length is relational with respect to velocity as the **Lorentz transformation** on length shows. (Perceived) colour depends on wavelength of light, surface spectral reflectance of things, ambient light, and internal state of the observer (*inter alia*) and thus is relational. Solubility is relational as it depends as much on the solvent as the solute (not to mention other ambient conditions such as temperature and pressure). Electric charge, however, is not relational but absolute. All frames of reference "agree" on the magnitude of charge of a given thing.

Arity: The arity of a relation is how many objects can stand in a given instance of it; this need not be fixed - many relations (even functions!) of variable arity are known. This is a synonym or close relative of "polyadicity," "valence" (in linguistics), and "place" or "degree" of a predicate. (Strictly speaking many of these items have to do with predicates rather than properties or factual relations, but language is often loose on the matter.)

Boundary Condition: Initial or final conditions which constrain what the solution of a differential or difference equation represents. For instance, in the differential

equation:

$$\dot{x} = x$$

We solve this particular equation by writing it as:

$$\frac{dx}{dt} = x \text{ then rearranging and integrating we get:}$$

$$\frac{dx}{x} = dt$$

$$\int \frac{dx}{x} = \int dt$$

$$\ln x = t$$

$$x = e^t + C$$

(I have simplified by not introducing the integration constant until the end.) Here C is a boundary condition to the solution to the equation; it must be supplied, or the differential equation we started with results in a family of similar solutions. This would be fine in pure mathematics, but if one wants to predict (e.g.) a specific trajectory, one needs the constant of integration which is the boundary condition. It usually represents some aspect of the initial (occasionally final) state of the system. Note that a boundary condition can also be represented as a non-constant function. Also, note that in qualitative portions of the thesis I have made use of Lombard's qualitative understanding of boundary conditions.

Catalyst/Inhibitor: A catalyst is a chemical species which takes part in a chemical reaction that results in an increased rate of reaction that is not itself consumed by the reaction. An inhibitor is similar, except it slows down the rate of a reaction. For instance, platinum can be used as a catalyst in the hydrogenation of alkenes to speed up the formation of alkanes. The study of catalysis is **metaphysically** interesting as it allows investigation into notions of persistence (i.e. how a catalyst takes part a reaction but survives it), properties and **levels of reality**.

Conservation Laws: The hypotheses that certain properties

(e.g. energy, momentum, angular momentum) do not "pass away" or "come into being" in any process whatsoever. These may have to do with fundamental symmetries in the universe (Stenger 2000 discusses this connection in the light of the **Noether theorems**.) They may be regarded as principles of **metascience** as they are very ontologically basic and would be "given up" as an extreme last resort in interpreting the result of an experiment.

Epistemology: The branch of philosophy dealing with human knowledge and its justification in general (rather than knowledge of certain kinds.)

Electricity/Magnetism (E&M): Two features of the universe intimately connected with optics and the **special theory of relativity**. Important **metaphysically** as the facts of E&M illustrate interplay between **absolute** and **relational** properties.

Emergent Property: A property which is possessed by an object that is not possessed by its components.

Field: This term has two scientific uses which must not be confused (see, for example, Peressini 1999 [1998]). One is that of a physical thing, extended and occupying all points of space in a given volume. These are traditionally regarded as having infinite degrees of freedom. (Whether this is correct or not is a matter of some debate: see Auyang 1995 for the traditional view, Stenger 2000 for a heterodox one and a discussion of the matter. The current thesis does not require commitment to either view.) The second meaning has no use in the current thesis and is only remarked upon here to avoid its confusion with the first definition. In pure mathematics, a field is a mathematical function from a given domain space to a vector space. Note that in physics one often uses the notion of a field in this sense to represent fields in the physical sense which can result in some confusion.

Frame of Reference: A frame of reference is a coordinate system tied to a specific concrete thing or system. Strictly speaking, a frame of reference has to be understood as a thing (or perhaps a *sui generis* object) as it has a velocity; this detail shall not affect understanding in this thesis much. Furthermore, in the current work, frames of reference are generally understood to be **inertial** unless otherwise stated. This restriction is the justification for the "special" in its title.

Galilean Relativity: The thesis that the laws of motion of things are independent of position in the universe. This can be understood both as a constraint on the form of reconstruction of the laws in law statements, and on the objective patterns themselves. For example, Galileo's own law statements of projectile motion apply regardless of initial position. The thesis opposed the Peripatetic sublunary/superlunary distinction in understanding motion that was common in Galileo's time.

General Theory of Relativity (GR): The generalization of special relativity to accelerated (i.e. non-inertial) frames of reference. It hence deals with effects due to gravitation. This thesis is not concerned with GR.

Inertial: Of a frame of reference, unaccelerated. (Alternatively, a frame of reference is inertial just in case it is one in which Newton's second law applies without introducing fictitious forces.)

Lawfulness Postulate: The **metascientific** (metaphysical, in this case) postulate that the universe contains objective patterns (i.e. objective relations between properties). Presupposed by (and confirmed by!) all scientific research, the (meta)philosophy of the present author, and common sense. Note that this does not entail anything directly about our knowledge (if any) of said patterns.

Levels of Reality: Different **things**, systems and events occur

with many qualitatively different emergent properties. **Things**, systems and events at one given level are in a sense ontologically at a par. What these levels are is subject to some debate; examples include: physical, chemical, biological, social, technological. Each ontologically presupposes the prior levels but is not thereby strongly reducible to them because of the emergent properties in question. Another way of putting this is that chemical things "inherit" some (not necessarily all) physical properties, biological things "inherit" some chemical properties and some physical properties, etc.

Lorentz Transformation: The mathematical expression used to calculate values of certain physical quantities in other frames of reference from their values in a given frame. A common quantity (a proportion of sorts) is found in all of these. Often symbolized γ , it has value

$$\gamma = \sqrt{1 - \frac{v^2}{c^2}}$$

where v is the speed of the other frame in the relevant direction and c is the speed of light. Note that this reduces to a constant coefficient of 1 in the limit of 0 velocity or infinite speed of light. For example, the amount of time T in a frame moving relative to a frame with velocity v where the time in the rest frame in question is T_0 is given by

$$T = \frac{T_0}{\gamma}$$

Einstein recognized that the basic law statements in physics ought to be invariant under the Lorentz transformation, and enthroned this principle in the center of **SR**.

Materialism: The thesis that everything real is made of matter (that is, are changeable/possess energy: Bunge 1977). This is an implicit assumption in my theory and its criticism of others. This should not be confused with physicalism, the thesis that only physical properties are real. (cf. **emergent**

properties, levels of reality.) On this view mathematical objects (numbers, vectors, sets, **fields** in sense 2, etc.) are to be considered as fictional when regarded in themselves.

Maxwell's Equations: The four fundamental law statements of electricity and magnetism. They state (approximately) how electric and magnetic fields are interrelated and propagate.

Mereology: The study of the various part-whole relations.

Metaphysics: The study of the most general features of reality. In this work, this is taken to include analyzing and synthesizing concepts about the general nature of the world (time, space, **thing**, event, cause, property, determination, etc.) found in many or all sciences and technologies. Not to be confused with matters of reference in **semantics**, which can at best suggest a metaphysics. (See chapter 1.) Metaphysics, on this view, does not consist in giving an exhaustive list of the world's contents but is more along the lines of the Aristotelian or Kantian notion of the categories.

Metascience: The disciplines that concern themselves with the normative (epistemological, ethical, logical, etc.) and other basic principles of science. Includes the general study of methodology and the philosophy of science.

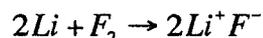
Mixed Science: A science that is both biological and social in character. Examples: linguistics, psychology, demography.

Noether Theorem(s): It can be shown that certain kinds of spacetime symmetries entail various **conservation laws**. This connection is one reason to suppose that the conservation laws are extremely "important." For example, time translation symmetry gives rise to conservation of energy, space translation symmetry entails conservation of momentum, and space rotation symmetry entails in turn angular momentum conservation. (See Stenger 2000a for more on this subject and its possible metaphysical significance.)

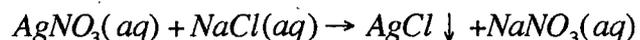
Object: This term is impossible to define as it is one of the most basic of all ontological concepts. Does not include space and time except in the context of **substantivism** nor relations and properties generally. Does include purely formal objects, i.e., those studied in mathematics, logic, the general theory of grammars, etc.

Ontology: Synonym of metaphysics.

Oxidation-reduction reaction: In chemistry, a chemical reaction is said to be an oxidation-reduction reaction if one atomic species undergoes a gain in electrons (the reduced species) and the other loses them (the oxidized species). Note that oxidation-reduction reactions need not involve oxygen. An example of the latter is the reaction of lithium metal with fluorine gas - lithium is oxidized, fluorine reduced (I have written the product ionically to emphasize this):



Not all reactions are of this form; some preserve electronic configuration. Example - aqueous silver nitrate reacting with aqueous sodium chloride producing (assuming the solution becomes saturated) silver chloride:



Phenomenological: In metascience: of a law statement that does not make reference to mechanisms. Example from physics: Hooke's Law. Example from chemistry: rate laws from chemical kinetics. The distinction between phenomenological and mechanistic is not hard and fast. Newton's understanding of gravitation is sometimes regarded as being at the borderline. Current understanding of prerelativistic gravitation is not phenomenological, because of its use of the notion of a **field** (sense 1) - which was introduced after Newton's time.

Quantum Field Theory (QFT): Auyang defines QFT as (1995, pp. page 122

3):

"[...] the union of quantum mechanics and special relativity. It is our most [ontologically - the present author] fundamental physical theory and provides the conceptual framework for the twentieth century's answers to questions about the basic structure of the physical world."

QFT thus can serve as a first level test bed for **metaphysics** as well as suggest metaphysical hypotheses. Both Auyang's book and the present work do these two tasks to varying degrees.

Realism: Within this thesis, the viewpoint that the world as it really is can be known (if only partly). Critical realism is a fallibilistic, melioristic version of realism. Scientific realism is a critical realism with the additional postulate that science is the most successful and best way to investigate reality, especially when joined with an appropriate philosophy. Note that these are epistemological theses.

Rest Frame: The **inertial frame of reference** centered on an object. So called because the velocity of the object in this frame is zero.

Semantics: The branch of philosophy that deals with notions of reference, truth, interpretation, meaning, and so on. Not to be confused with metaphysics. Semantics thus studies language-world relations and metaphysics the world itself. This distinction requires at least a weak form of **realism** (it merely supposes that language and the rest of the world are distinct.)

Special Theory of Relativity (SR): The theory of motion dealing with unaccelerated (**inertial**) **frames of reference**. Strongly connected to **E&M** as one key prediction of E&M was the existence of waves that travel at constant velocity regardless of the state of motion of the source or receiver (disregarding the postulated ether). This prediction is enthroned as a postulate in SR.

Subjectivism/Objectivism: Any number of theses that assert either that subjects are prior to other objects ontologically (e.g. Berkeley's idealism) or that humans "cannot escape their perspective" are subjectivist. The latter must not be misunderstood in the light of my rejection of subjectivism throughout this work. I am not denying we have a finite perspective as humans. However, I do think we can be objective (the opposite of subjective) in so far as we can obtain many sufficiently true statements that have nothing to do with human experience. "Lithium metal reacts with chlorine gas to form a salt" is one such possibility. Note that subjective/objective is, however, not the same as false/true. "I dislike ice cream" is subjective and false in the case of the present author, and "atomic nitrogen has 1 valence electron" is objective and false. This work is thus objectivist and is intended to be more or less true.

Substantivism: The thesis in philosophy of space and time that space and time are **objects** (or even **things**), not (merely) relations. Apparently falsified by **SR & GR**, though nothing about its truth or falsity is presupposed by this thesis except as noted elsewhere.

Thing: Less general than "**object**," I use it to mean a single, factual (as opposed to formal) object with its properties. My notion does not include changes and hence not events; things (and systems) undergo events. It also does not include properties in themselves - things, and objects generally, have properties. (This is a thesis of non-Platonism as I also assert there are no properties in themselves. This is implicitly understood in chapter 3, as otherwise I would have considered the possibility of events that are not events in things but merely in uninstantiated properties.)

Appendix 2 - Axioms for the Special Theory of Events

The following is meant as a brief précis of chapter four, section four which contains the 9 central postulates of the current theory of events. Not included are the supporting postulates from sections one through three concerning properties and causation and other miscellaneous postulates.

(1) Events can be described qua "happenings" (i.e. in terms of other events) or qua property changes.

Thus, an event can be represented as a 7-tuple:

(1a) $\langle \Delta x, \Delta y, \Delta z, \Delta t, F, C, E \rangle$, or a 7-tuple:

(1b) $\langle \Delta x, \Delta y, \Delta z, \Delta t, F, P_1, P_2 \rangle$

(2) The spatiotemporal location $(\Delta x, \Delta y, \Delta z, \Delta t)$ is the minimum subject of what is either affected by the cause (i.e. an object or a proper part of one) or which undergoes the proper property changes in question (in (1a), (1b) respectively).

(3) Events can combine along the temporal dimension to form larger, extended events.

(4) Events which are in close spatiotemporal proximity can combine to form larger events.

(5) Events can occur without cause.

(6) There are no effectless events.

(7) Some of the features we describe events (causally or otherwise) with are not strictly speaking those properties involved in the event proper but boundary conditions.

(8) Both (1a) and (1b) "really describe" the event taken together.

(9) Events are concrete, unrepeatable particulars.

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