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ON THE INDIVIDUATION OF EVENTS

As Donald Davidson has pointed out,[1] there are many good reasons for taking events seriously as concrete individuals, i.e., as numerically unique entities which have location in space and time. In the first place, both action theory and explanation seem to call for events *qua* unrepeatable, spatially located particulars. In excusing an action (a species of event) we frequently describe the action in a number of different ways. My daughter's eating all the brownies in the refrigerator this afternoon is the very same action as my daughter's eating the dessert for tonight's dinner. But she is blameless in that she didn't know that the brownies were the dessert. Similarly in explaining the expansion of a piece of metal, scientists may redescribe it in a number of different ways: in terms of the kind of material it is, in terms of the heat capacity of metal, in terms of molecular bonding and the motion of molecules. All this talk of redescription makes little sense if there are no individuals to be described in the first place. Moreover, as Davidson has shown, an ontology of unrepeatable events has great utility for the purposes of accommodating adverbs in predicate logic, allowing us to validate the intuitive inference from, say, 'Elspeth ate the brownies quickly under the deck at noon' to 'Elspeth ate the brownies'. In brief, action theory, causation, explanation, and logical theory all seem to call for events which are concrete individuals, as opposed to abstract (timeless) and general (property-like).[2]

Nevertheless the claim that events are concrete individuals faces a major hurdle. If events are concrete individuals, then it should be possible to provide identity conditions for them;[3] for as Quine has cautioned us, "No entity without identity".[4] Unfortunately, however, the most widely discussed proposals for such conditions, by Donald Davidson, John Lemmon and Jaegwon Kim, are beset with serious problems. In order to better understand the difficulties involved in formulating identity conditions for events, let us briefly review these three proposals, paying particular attention to the problems commonly associated with them.

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According to Davidson,[5] two events are the same event if and only if they have exactly the same causes and effects:

$$x = y \leftrightarrow [(z)\ (z \text{ caused } x \leftrightarrow z \text{ caused } y) \text{ and } (z)\ (x \text{ caused } z \leftrightarrow y \text{ caused } z)]$$

That is to say, Davidson individuates events in terms of causes and effects. As a number of philosophers have hastened to point out,[6] Davidson's definition looks circular. Nevertheless it isn't formally circular, since there isn't an identity sign in the definiens. Rather, as Quine has recently noted,[7] it is circular as an individuation; for it individuates events by quantifying over causes and effects which are, themselves, events. In other words, the circularity involved in Davidson's proposal has to do with the fact it individuates events only if they are already individuated. As a result it fails to provide adequate identity conditions for events.

This brings us to John Lemmon's proposal.[8] He formulates identity conditions for events in terms of identity of spatiotemporal region: two events are the same if they occupy exactly the same spatiotemporal regions. Although Lemmon's criterion is not circular (either formally or as an individuation), it faces a serious problem. Unlike physical objects, different events seem to be able to occupy exactly the same spatiotemporal region. As an example, consider a sphere which is simultaneously rotating and changing color. The rotating and the changing of color occupy the same spatiotemporal region, viz., the region of the sphere. Accordingly on Lemmon's criterion, they turn out to be the same event. Yet we ordinarily think of the rotating and the changing of color as quite different occurrences. On such grounds many philosophers, most notably Davidson,[9] have rejected Lemmon's proposal as inadequate.

The third widely discussed proposal is by Jaegwon Kim.[10] According to Kim an event is an exemplification of a property (n-adic attribute) at a time by a physical object (ordered n-tuple of objects). Identity conditions for events are formulated in terms of sameness of properties, times and physical objects. This means that two events cannot be the same unless they are constituted by exactly the same physical objects. The problem is that some events can be identified without reference to any physical object (e.g., that shriek, this flash, that desire), which suggests that some events may not be individuatable in terms of physical objects.[11] Indeed it is not at all obvious that fluctuations in gravitational

and electromagnetic fields always involve the exemplification of properties by physical objects. Moreover even if they did, it still wouldn't follow that events can be universally individuated in terms of physical objects. For as Strawson has persuasively argued,[12] one can make sense of a spaceless world of sounds – a purely temporal world of disembodied melodies, booms, bangs, shrieks, etc. To the extent that such sounds can be said to constitute bona fide events in a genuinely possible world (Strawson's 'No-Space World'), Kim's criterion fails to have the requisite generality.

The literature on events is replete with ad hoc attempts to deal with these difficulties. Defenders of Kim stubbornly deny that worlds such as Strawson's No-Space World are genuinely possible. Those sympathetic with Lemmon boldly abandon common sense and identify the rotating of the sphere with the changing of the color of the sphere.[13] There are even a few stalwart souls who defend Davidson against the charge of circularity by arguing that the category of event is basic, and, hence, that it is not possible to give a noncircular individuation of events.[14] Ideally, however, we would do better than this. Part of the job of an analysis of events is to explain our ordinary, everyday understanding of when two events are the same event. To the extent that Davidson's, Lemmon's, and Kim's accounts fail to do this, they are simply inadequate. What we need is an alternative, an account which is able to noncircularly individuate events in a manner more consistent with our intuitions regarding event identity. It is the purpose of this paper to provide such an account.

1.

The question is what, other than physical objects and space-time regions, could possibly individuate events? The answer I propose is change. Unlike the proposals of Kim and Lemmon, who explicitly admit "unchanges" as bona fide events,[15] this proposal has the advantage of being remarkably consistent with our ordinary, everyday concept of an event. We commonly think of an event as an occurrence, e.g., the ringing of a telephone, the shattering of a window, the signing of a peace treaty. Moreover the idea that events involve changes is not new. In a recent book, Lawrence Lombard has identified events with changes'.[16] Unfortunately, however, Lombard's account is inadequate for our purposes. The problem is that he individuates changes in terms

of physical objects; in his words, a change is ". . . a movement of an object at an interval of time in a quality space".[17] Thus he ultimately individuates events in terms of physical objects. As a result Lombard's account faces the same problem as Kim's: He is not able to accommodate objectless events such as disembodied shrieks and flashes. If we are to be able to use change to escape the problems with Kim's account of events we must find some other way of individuating changes.

On the other hand, if we are to be able to escape the problems faced by Lemmon's account we can't individuate changes in terms of space-time locations either. But don't physical objects and space-time regions exhaust the possibilities?

Fortunately there is another candidate for a basic particular and that is the condition. By "condition" I do not mean a proposition upon which the truth of another proposition depends. That is to say, I do not have in mind a logical condition. Rather, I have in mind the sort of thing one refers to when one speaks of the health of a woman, the economy of a country or the temperature of a liquid. In order to differentiate conditions of this kind from logical conditions, I will henceforth refer to them "as existential conditions". In the remainder of this section I develop an account of change in terms of existential conditions. Subsequently (in Section 3) I define "event" in terms of change.

The idea that nonlogical conditions are essential ingredients in change goes back at least as far as Aristotle, who wrote,

> . . . in a process of change we may distinguish three elements – that which changes, that in which it changes, and the actual subject of change, e.g., the man, the time, and the fair complexion.[18]

On Aristotle's account, it is not the man but his fair complexion which actually undergoes the changing. The fair complexion of the man is something distinct from the man. It is what I have termed an "existential condition" of the man. That is to say, according to Aristotle, the proper subjects of change are existential conditions, as opposed to physical objects.

That existential conditions at least hold forth the promise of being able to individuate changes can be seen as follows. Insofar as light intensity and temperature can be considered to be different existential conditions of the same region of space, one and the same region of space can be said to be simultaneously undergoing different changes,

viz., a change in brightness and a change in temperature. Similarly, although it seems possible for a shriek to occur in the absence of any physical object, it does not seem possible for a shriek to occur in the absence of any existential condition; for a shriek is nothing more nor less than a certain kind of change in acoustic conditions. In short, different changes appear to be associated with different existential conditions.

The question remains: Can existential conditions be construed as unrepeatable entities which do not owe their individuality to either physical objects or space-time regions? It is my contention that they can.

To begin with, let us differentiate between two different kinds of existential conditions. I will call them "states" and "phases". I define them as follows:

(D1) A *state* is a determinate property (or *n*-adic relation).
(D2) A *phase* is a determinable property (or *n*-adic relation).

The distinction between determinate properties and determinable properties is not a new one; W. E. Johnson is credited with having made it more than sixty years ago.[19] Determinable properties are indefinite properties such as the property of simply having location, color or temperature. In contrast, determinate properties are definite properties (values of determinables), two examples being 'having a temperature of 100 °C' and 'being two miles north of my front door'. Thus, according to (D1), the property of being 100 °C (having a specific value of temperature) is a state. This is in keeping with the way in which we ordinarily use the term "state". More specifically, when I refer to the state of temperature of a liquid, I do not mean to designate merely that the liquid has temperature (a determinable property) but, rather, that the liquid has some specific value of temperature. In contrast, a phase of temperature is constituted by temperature simpliciter, as opposed to a definite degree of temperature.[20]

It is important to appreciate that determinable properties are not reducible (so-to-speak) to determinate properties in any straightforward way. Each determinable property (e.g., temperature) corresponds to a set of determinate properties (100 °C, 530 °C, 2 °C, etc.), which are often described as "falling under" the determinable property. One feature of the relationship between a determinable property and its corresponding determinate properties is that if an object has a determi-

nate property (e.g., 100 °C), then it is entailed that the object also has the corresponding determinable property (temperature). However the converse is not the case. That is to say, from the fact that an object has a determinable property (temperature) it does not follow that the object has a certain determinate property (say, 100 °C). Any one of the corresponding determinate properties will do; in the case of the determinable temperature, the determinate property could just as well be 2 °C or 501 °C as 100 °C. Of course this does not prove that no sense can be made of the notion that a determinable property is reducible to its corresponding determinate properties. One possibility would be to identify determinable properties with classes of determinate properties while rejecting the notion that classes of properties constitute genuine properties.[21] But to pursue this issue any further would divert us from our primary task, which is to provide an analysis of change. Hence in this paper I am merely going to assume that a determinable property is a bona fide property which is distinct from its corresponding determinate properties, e.g., that the property of simply having temperature is both different from and as real as the property of being 100 °C. That is to say, on my view, phases are constituted by irreducibly indefinite aspects (respects) of reality.

Unfortunately, however, the distinction between determinate properties and determinable properties is notoriously vague. For example, redness is determinate with respect to color but determinable with respect to crimsonness. Thus it seems that redness will turn out to be both a state and a phase, which undermines the notion that there is an ontologically significant difference between states and phases. It is possible to avoid this undesirable result by accepting the existence of basic determinate properties, where a basic determinate property is a property which is (1) absolutely definite in the sense that it does not admit of any further differentiation and (2) not further analyzable in terms of other properties. Admittedly, most of the determinate properties we ordinarily identify fail to be basic in the above sense, e.g., determinate temperature is absolutely definite (unlike redness, being 100 °C is not further differentiable) but it is not basic since it is further analyzable in terms of mean kinetic energy. But this doesn't prove that there aren't any. Moreover, for my purposes it doesn't matter whether the postulated determinate properties are basic in the sense of representing fundamental features of physical reality or just basic relative to our current theories and concerns. In either case there will be a level

of analysis at which it is possible to identify a property as a state or phase in an absolute (vs. relational) sense. Unfortunately it is beyond the scope of this paper to explore this issue any further. My point here is only that if the hierarchy of determinable and determinate properties bottoms out, and we have no reason to believe it doesn't, then we can draw a precise boundary (at that level) between states and phases. As we shall soon see, such a distinction would have the distinct advantage of securing for us a fundamental level for the analysis of change.

This brings me to the entities which will play the most crucial role in my analysis of change, concrete phases. Concrete phases are the entities I will use to individuate changes and, hence, in the final analysis, events. I define them as follows:

(D3) A *concrete phase* is an instance of a phase.

As instances of (determinable) properties, concrete phases are particularized properties; particularized properties are often called "tropes".[22] Like physical objects, particularized properties are unrepeatable entities. To see this, consider a red book and a red jacket. Here we have two different things and also two different instances of redness. Even supposing that the book and the jacket resemble each other exactly in their shade of redness (they exemplify the very same property), we still have numerically different rednesses. On my account, these different instances of redness constitute different concrete phases. In short, a concrete phase can be thought of as an instance of a generalized aspect of reality, e.g., an instance of undifferentiated temperature, as opposed to an instance of a particular value of temperature. The question remains can concrete phases be individuated by properties, physical objects or space-time regions, or some combination thereof if they can, then they will not be able to individuate changes in such a way as to allow the identification of events with changes to overcome the difficulties mentioned in the beginning of this article.

Clearly concrete phases cannot be individuated by properties, physical objects or space-time regions alone. Because different concrete phases can involve the very same property (e.g., this instance of temperature and that instance of the same temperature), they cannot be individuated in terms of their constituent properties alone. Moreover different concrete phases can involve the very same physical object, e.g., one and the same sphere can simultaneously instance both temperature and orientation. Hence concrete phases cannot be individuated

solely in terms of the physical objects involved. Finally different concrete phases can be simultaneously present in the same region of space and time. As an example, a region of space can be simultaneously warm and bright.

It might be thought that one could achieve the desired individuation of concrete phases with some combination of properties and either physical objects or space-time regions. Indeed in a recent book, Jonathan Bennett has argued that particularized properties ("tropes") can be individuated in terms of complexes of properties and space-time regions ("zones"); in his words, a trope is ". . . the instantiation of a property at a zone".[23] Thus Bennett is able to distinguish the brightness of a particular region of space-time from the temperature of the same region of space-time in terms of their involving different properties (color vs. temperature). Similarly he is able to differentiate the temperature of one region of space-time from the temperature of another region of space-time in terms of their involving different space-time regions, even supposing that the values of temperature are identical.[24]

The problem is that it is not at all obvious that every case of a different instance of the same property always involves a difference in spatial location. Although lighting conditions extend in space, acoustic conditions such as timbre (tone) do not seem to have any spatial properties whatsoever. Similarly mental conditions (e.g., of belief, desire) may lack spatial location.[25] In this context it might seem that one could individuate concrete phases not involving physical objects or spatial regions in terms of complexes of properties and times. But such an individuation would lack the requisite generality, since it is not possible to individuate all concrete phases in terms of mere differences in properties and times, e.g., simultaneous but different instances of the same shade of color cannot be individuated solely in terms of complexes of properties and times. Moreover we run into the same problem if we try substituting physical objects for space-time regions. Just as it is not obvious that every case of a different instance of the same property always involves a difference in spatial and/or temporal region, so it is not obvious that every case of a different instance of the same property always involves a difference in physical object, e.g., two disembodied instances of the very same pitch. In short, it is in general not possible to individuate concrete phases in terms of some combination of properties, spatiotemporal locations or physical objects.[26]

So what is it that all concrete phases have in common which can

distinguish them from each other as the same or different? What they all have in common is that they are instances of properties. Concrete phases differ if and only if they are constituted by different instances of (the same or different) properties. In other words, what makes two concrete phases of temperature, involving exactly the same values of temperature, is nothing more nor less than the fact that they are different *instances* of temperature. Insofar as physical objects and space-time regions are commonly thought to exhaust the category of basic concrete particular and neither physical objects nor space-time regions can, in general, individuate concrete phases, this suggests that the individuality of concrete phases is primitive, i.e., that they are nakedly numerically distinct. In this light, I boldly propose that we construe concrete phases as basic individuals. This, of course, means that I am introducing a new kind of primitive entity (viz., an instance of a property) and, hence, am open to charges of ontological excess. My defense against this charge is two-pronged. First, although it is beyond the scope of this paper to pursue the subject in any detail, it seems likely that one could use concrete phases to dispense with physical objects and space-time locations, defining the latter in terms of the former.[27] If I am right about this, then adopting concrete phases as basic individuals will result in a decrease (rather than an increase) in the number of basic individuals. But even if I am wrong about this there are compelling reasons for expanding our ontology to include concrete phases. As will become apparent in Sections 2 and 3, concrete phases have tremendous theoretical utility for the purpose of analyzing change, events and certain traditionally puzzling statements in natural language.

It is now time for us to return to Aristotle's proposal and make some sense of the claim that concrete phases are the existential conditions which are the proper subjects of change.

Remember that old puzzle about change: in order for something to change there must be a sense in which it remains the same (otherwise it simply ceases to exist) and a sense in which it becomes different (changes). There is a sense in which a concrete phase can be said to remain the same while becoming different. It can be said to remain the same in the sense that the instance of the determinable property which constitutes it does not go into and out of existence during the time in which the instances of the associated determinate properties (states) are going into and out of existence, e.g., a liquid whose temperature

is changing does not, at any time during the change, cease to have temperature. While remaining the same, it can also be said to become different in the sense that it takes on different determinate values (e.g., of temperature) during the change. More specifically, if one takes determinate properties (states) to be contingent properties of instances of the determinables they fall under (of concrete phases), then it seems that one can make good metaphysical sense of the Aristotelian claim that the proper subjects of change are conditions, viz., concrete phases, as opposed to physical objects.

The question arises: In what sense can change be said to be a property of a concrete phase?

Many changes are property-like in the sense that they are repeatable. Two different liquids can undergo the same temperature change, e.g., from 101 °C to 102 °C. Similarly the same liquid can undergo the same temperature change at different times. Nevertheless not all changes are repeatable, e.g., *that* temperature change, the sinking of the Titanic. In order to distinguish the former from the latter, I will henceforth refer to repeatable changes as "generic changes" and unrepeatable changes as "concrete changes".

Concrete change is constituted by the exemplification of different determinate properties (a difference in state) by a concrete phase. Accordingly let us define concrete change as follows:

(D4) A *concrete change* R is a pair $\{x, y\}$ such that x is the exemplification of a state s by a concrete phase CP at a time t and y is the exemplification of a state s' by a concrete phase CP′ at a time t', where
(i) t is earlier than t';
(ii) CP is the same concrete phase as CP′, and
(iii) s is not the same state as s'.[28]

Condition (i) of (D4) designates one member of each pair of state exemplifications constituting a concrete change as the first element and the other member as the second element. In order to distinguish these elements from each other I will henceforth refer to the first as containing the "initial state" and the second as containing the "terminal state". In effect, condition (i) orders the pair of state exemplifications involved in a concrete change.

The purpose of condition (ii) is to restrict the number of time-ordered pairs of state exemplifications which qualify as concrete changes to the

same concrete phase. Thus states of temperature which are exemplified by different concrete phases of temperature (e.g., the temperature of this liquid and the temperature of that sphere) will not qualify as a single instance of change; although they may be constituents in respectively different changes. This condition makes explicit the sense in which concrete phases can be said to be the subjects of change, namely, they remain the same while becoming different, i.e., while exemplifying different states.

Finally, condition (iii) excludes unchanges as genuine changes. It specifies that the states involved in an instance of change must be different.[29]

So what is the sense in which change can be said to be property-like? It is the sense in which different concrete changes can be said to be instances of the same kind of change, i.e., the same generic change. Thus, for example, we describe concrete changes constituted by the time-ordered differences in state ⟨100 °C, 101 °C⟩, ⟨2 °C, 4 °C⟩, ⟨1 °C, 100 °C⟩ as all being instances of warming and we distinguish them from concrete changes involving time-ordered differences in state such as ⟨101 °C, 100 °C⟩ and ⟨100 °C, 1 °C⟩, which are characterized as instances of cooling. What the pairs in the former set ostensibly have in common is the same relation among their states: the relation 'is a lower temperature than' holds between each pair of initial and terminal states, e.g., 100 °C is a lower temperature than 101 °C. This relation does not hold between the initial state and the terminal state of any pair of states in the latter set of temperature changes. In short, what different concrete changes in temperature appear to have in common is the relation between their initial and terminal values of temperature. I propose that we extend this idea to change in general as follows:

(D5) A *generic change* G is the set of all possible concrete changes $\langle x, y \rangle$ for which there exists some phase P and some relation R such that for every $\langle x, y \rangle$ in G, x is the exemplification of some state s and y is the exemplification of some state s' and
(i) s and s' both come under P and
(ii) s bears R to s'.

The possibility operator insures the generality of generic change – that a generic change in temperature such as "cooling" will include not only temperature values which actually have been instanced by the same

concrete phase but, also, any pairs of temperature values bearing the appropriate relation which could have been (but have not been and, perhaps, never will be) instanced by the same concrete phase.

The first condition of (D5) specifies that all the states involved in different instances of the same generic change come under the same phase. This seems right. As an example, we do not ordinarily think of a change in temperature and a change in color as both being instances of the same sort of generic change. Nor do we think of one and the same concrete change as involving pairs of states whose members come under different phases; an instance of 100 °C and an instance of a 10 kg cannot jointly constitute a single instance of concrete change, although they may be elements in separate concrete changes (in, respectively, temperature and mass).

Condition (ii) makes generic change fundamentally relational. It specifies that different instances of the same generic change have in common some specific relation among their initial and terminal states. There is, however, a potential difficulty with this and that is that there are no restrictions on R. As it stands, R can be any relation whatsoever. Consequently many seemingly arbitrary and insignificant sets of concrete changes (time-ordered pairs of exemplifications of differing states by the same concrete phase) will qualify as unique generic changes. In the case of temperature, for example, the four pairs of time-ordered differences in temperature state ⟨1 °C, 20 °C⟩, ⟨30 °C, 12 °C⟩, ⟨11 °C, 39 °C⟩ and ⟨70 °C, 72 °C⟩ have some (admittedly, very complex) relation in common and, hence, instances of them will qualify as instances of the same generic change.

The problem we are facing here is not a new one and it is not unique to change. It occurs whenever anyone tries to give an analysis of properties, whether relational or nonrelational, in terms of set membership. What is required is that we further restrict the number of sets of ordered pairs of states which can constitute genuinely different sorts of changes; i.e., we want to rule out sets like {⟨1 °C, 20 °C⟩, ⟨30 °C, 12 °C⟩, ⟨11 °C, 39 °C⟩, ⟨70 °C, 72 °C⟩} and retain sets like {⟨100 °C, 101 °C⟩, ⟨1 °C, 4 °C⟩, ⟨5 °C, 100 °C⟩, ⟨20 °C, 200 °C⟩, . . .}. In the case of temperature we might be able to achieve this by restricting R to linear orderings, since most generic changes in temperature (e.g., warming, cooling) appear to involve linearly ordered relations. Unfortunately, however, it is not at all obvious that generic changes in other phases do. Consider, for example, the differences in place involved in the oscillation of a

pendulum. Moreover it seems to me highly unlikely that those sets of concrete changes which we ordinarily classify as generic changes have in common some one set theoretic property (such as being a linear ordering) which those sets of concrete changes which we do not classify as generic changes lack. Assuming I am right about this, there are at least two approaches one can take to interpreting the R in condition (ii) of (D5).

One could reject the set theoretic supposition that a relation is nothing more nor less than a set of ordered pairs. More specifically one could interpret the relations involved in generic changes as physically real connections among states. These connections would amount to ways or manners of passing from an initial state to a terminal state. Thus the R in condition (ii) would designate more than a relation in the set theoretic sense. Those set theoretic relations not involving genuine bonds between states would not qualify as generic changes.

On the other hand, there is a long tradition in contemporary philosophy which takes change to amount to nothing more than differences over time. This view of change dates back at least as far as the work of Bertrand Russell,[30] who argued vehemently against taking the notion of an "intrinsic state of change" seriously. On Russell's account the only distinctions among relations available are set theoretic. Granting that I am right about there being no set theoretic basis for the claim that some sets of concrete changes have a common property which other sets of concrete changes lack, it will be necessary to take a completely egalitarian attitude towards sets of concrete changes meeting condition (i) of (D5); ontologically speaking, there simply isn't a significant difference between them. Accordingly we will have to explain the fact that we ordinarily make far fewer distinctions among concrete changes than are called for by (D5) in terms of our own idiosyncratic ways of dividing up the world. Had our interests, purposes and powers of discernment been different, we would have classified instances of concrete change differently in terms of whether or not they are members of the same (or different) generic change(s).

Which of these interpretations of the relation involved in change is correct: Does real concrete change involve a genuine bond between concrete states or only a time-ordered difference in concrete states? I have argued elsewhere that the first one is.[31] However either interpretation of the R in (D5)(ii) is compatible with the main thesis of this paper, which is that the essential ingredient in an event is change.

Accordingly, in what follows, I will leave open the question as to its ultimate status.

2.

There are a number of advantages to the account of change which I have just adumbrated. In the first place, change is commonly described in science in terms of existential conditions, as opposed to physical objects or the contents of space-time regions. Nowhere is this more evident than in contemporary dynamical systems theory.[32] Dynamical systems are represented in terms of vectorfields defined on state spaces. In a one dimensional state space, each state corresponds to a determinate property (e.g., 101 °C, 1 °C, 200 °C) and all the determinate properties to which the states in the state space correspond come under the same determinable property (temperature). Thus a one dimensional state space corresponds to what I have called a phase. State spaces may be multidimensional, in which case the state space corresponds to a complex phase, each axis of the state space representing a single phase. In a multidimensional state space what is ordinarily called a "state" corresponds to an ordered *n*-tuple (one for each phase) of determinate properties. Accordingly the "states" in a multidimensional state space may be thought of as complex states, in my sense of the word. Most importantly, change is represented in a state space (whether one dimensional or multidimensional) as a "trajectory" (time-ordered curve) connecting different states. That is to say, change is represented in dynamical systems theory in terms of time-ordered differences in states coming under the same phase (state space), as opposed to being represented in terms of differences in physical objects or the contents of space-time regions. In brief, the account of change developed in the first section of this paper is remarkably consistent with the way in which scientists characterize change.

Furthermore it is very easy to accommodate natural language in my account of change. When speaking about change we often make statements such as: (1) the temperature of the oven is increasing; (2) the pitch of the sound is decreasing; (3) the color of the liquid is darkening. It seems quite natural to interpret the subject expressions in these sentences as referring to particularized determinable properties. More specifically one can take the subject expression in the first sentence as designating an instance of temperature – the temperature

of *that* oven and no other temperature. Similarly the expression "the pitch of the sound" can be construed as referring to a particular instance of pitch. In other words, expressions such as "the temperature of the oven", "the pitch of the sound" and "the color of the liquid" can be readily construed as designating concrete phases.

To this I can imagine the following objection. When someone utters an expression such as "the temperature of the oven" they ordinarily mean to designate more than a concrete phase of temperature (an instance of undifferentiated temperature). They also mean to designate the fact that the oven has a particular value of temperature, even though they may not know what it is. With this in mind, let us consider the following variation on an infamous sentence: "The temperature of the oven is 100 °F and rising". The notoriousness of sentences like this one derives from the difficulty of providing them with an adequate semantic analysis.[33] The question is what sort of entity is "being 100 °F" and "is rising" being predicated of? The syntactic structure of the sentence certainly suggests that "100 °F" is being predicated of an instance of determinable temperature, viz., the temperature of that oven. This suspicion is further reinforced by the observation that it doesn't make much sense to predicate "rising" of 100 °F, which is what one would be doing if one took the expression "the temperature of the oven" as referring to an instance of determinate temperature. The problem is that an instance of 100 °F can't possibly rise; it can only cease to exist. On the other hand we can make good sense of the sentence if we take "100 °F" and "rising" as both being predicated of the temperature of the oven qua instance of determinable temperature. For the concrete phase of temperature can be said to have the contingent property of being 100 °F and it can also be said to be taking on increasingly higher values of temperature. In short, it makes a great deal of sense to interpret an expression such as "the temperature of the oven" as designating a concrete phase, as opposed to a concrete state.

Nevertheless when speaking about change we also make statements such as: (4) the rock is falling; (5) the child is growing; (6) the lake is warming. Here change (falling, growing, warming) seems to be predicated of physical objects (a rock, a child's body, a lake), rather than concrete phases. Can sentences such as these be given an interpretation which is compatible with my claim that concrete phases are the proper subjects of change?

The first thing to notice is that a sentence such as "The rock is falling" can be readily paraphrased as "The position of the rock is getting closer to the earth's surface". Similarly the sentence "the lake is warming" can be paraphrased as "The temperature of the lake is increasing". Paraphrased in this way, sentences (4) through (6) can be analyzed as being about the exemplification of a change (getting closer to the earth's surface, increasing) by a concrete phase, as opposed to a physical object simpliciter. Hence sentences of this kind do not appear to pose a problem for my account of change.

This brings us to the predicate expressions in sentences (1) through (6). Just as the subject expressions in sentences (1) through (3) can be interpreted as designating concrete phases, so the predicate expressions in these sentences can be interpreted as referring to generic changes. That is to say, predicates such as "is increasing" and "is decreasing" can be readily construed as designating relations among states (of, respectively, temperature and pitch) which represent ways of changing, as opposed to particular changes. In the case of the oven whose temperature is said to be decreasing, the oven does not have to loose or take on any particular values of temperature. Any values will do so long as the initial value is higher than the terminal value. Accordingly an oven whose temperature goes from 100 °C to 101 °C and an oven whose temperature goes from 450 °C to 500 °C are both cases in which the temperature of an oven can be said to be increasing. Similarly two different liquids having different colors can both be said to be darkening. In this context it is worth noting that the predicate expressions in sentences (4) through (6) designate ways of changing which are restricted to specific phases, the term "falling" designating a way of changing places, the term "growing" designating a way of changing size and the term "warming" designating a way of changing temperature. Thus in asserting that a lake is warming one implicitly specifies which phase of the lake is undergoing the increase, viz., its temperature as opposed to its size. This is what makes it so easy to paraphrase a sentence such as "the lake is warming" into a sentence predicating a generalized change relation (increasing) of a concrete phase (the temperature of the lake).

3.

It is now time to return to the difficulty with which we started, viz., the problem of providing satisfactory identity conditions for events. I define an event as follows:

(D6) An *event* is a concrete change.

In other words, an event is constituted by the time-ordered exemplification of differing states by the same concrete phase. Accordingly an event can be represented as $\langle[\text{CP}, s, t], [\text{CP}, s', t']\rangle$, where "CP" ranges over concrete phases, "s" and "s'" range over differing states, "t" and "t'" range over differing times, and "[ ]" denotes the triadic relation of exemplification. Thus events turn out to be unrepeatable individuals whose identity conditions can be formulated in terms of sameness of concrete phase, time-ordered pair of differing states and times. In other words, two events are identical if and only if they involve the same concrete phase exemplifying the same initial and terminal states at the same times. The upshot is that we can interpret nominalized sentences such as "the warming of the oven", "the stabbing of Caesar" and "the explosion of the space shuttle" as referring to events; for such expression represent nominalizations of sentences (e.g., "the oven is warming") which can be readily paraphrased into still other sentences ("the temperature of the oven is increasing") explicitly predicating generic change (increasing) of a concrete phase (the temperature of that oven). It remains to be shown that this account of events is superior to others currently being discussed in the literature

It should be obvious that my proposal escapes the problem commonly associated with Kim's and Lombard's accounts. Insofar as I do not take events to be ontologically dependent upon physical objects but, rather, upon concrete phases, which may or may not involve physical objects, a disembodied shriek will qualify as a bona fide event. Similarly my proposal is able to evade the problem frequently associated with Lemmon's analysis. Because different concrete phases (e.g., spatial orientation, color) can occupy the same spatiotemporal locations, different events can occupy the same spatiotemporal locations. Thus the rotating of the sphere and the changing of the color of the sphere turn out to be different events. Finally my account is superior to an account of events recently proposed by Jonathan Bennett.

According to Bennett, an event is a particularized property (a "trope"), as opposed to a complex consisting of a particularized determinable property (concrete phase), determinate properties (states), and times.[34] As discussed in Section 1, Bennett individuates particularized properties in terms of space-time regions ("zones"). As a result he is unable to admit occurrences in Strawson's No-Space World as bona fide events, nor, for that matter, is he able to countenance Cartesian

mental occurrences as events. Nevertheless such occurrences are event-like and they ought to be classified as such, even supposing that they don't exist in our world. On my view they do get classified as events. For even though it lacks physical objects and spatial locations, the No-Space World does not lack concrete phases and it is these conditions (of pitch, timbre, etc.) which make change (in pitch, timbre, etc.) possible in a spaceless world. In other words, without concrete phases, change is impossible. With concrete phases, change is possible, even in the absence of physical objects and spatial locations. And where there is change (happenings) there are events. In short, my theory of events is more consistent with our intuitions regarding event identity than any account currently available in the literature.

The remainder of this section is devoted to showing how my account of events can handle some notoriously problematic cases of event identity.

One of the more infamous puzzles about event identity revolves around the question of whether the following expressions describe the same or different events: (1) "the death of Xantippe's husband"; and (2) "the widowing of Xantippe". Couched in terms of my analysis, this amounts to asking whether the death of Xantippe's husband (Socrates) involved the same concrete phase, time-ordered pair of differing states and times as the widowing of Xantippe.

The death of Xantippe's husband involved a change in the condition of her husband's health whereas the widowing of Xantippe involved a change in her marital condition. Conditions of health and marital conditions are different phases, the former is natural (biological) whereas the latter is artificial (legal and/or religious). Accordingly the events concerned must also be different. Thus on my analysis "the death of Xantippe's husband" does not describe the same event as "the widowing of Xantippe".

A few philosophers have maintained that the death of Xantippe's husband is not a different event from the widowing of Xantippe.[35] This allegation is most often advanced by advocates of the Lemmon criterion, who argue that the widowing and the dying occurred at the same time and place. But does it really make sense to claim that the widowing of Xantippe occurred at the same time and place as the death of her husband, Socrates?

Just as marital conditions are legal or religious circumstances or both, changes in marital conditions (whether widowings, divorcings or

annulments) are legal and/or religious matters. The time of a widowing is at whatever time the state or church declares it to be and, depending upon the circumstances and accuracy of the time pieces involved, this may vary substantially from the actual time of death of the husband. Indeed it can take years for a woman whose husband mysteriously disappears (and whose body is never found) to be declared a widow, even though her husband may have been killed within hours of his disappearance. Similarly the claim that the widowing of Xantippe occurred in the same place as the dying of her husband seems implausible. Xantippe's widowing is constituted by a change in her marital condition. If this change occurred in the prison where Socrates died, then it follows that her marital condition (that which changed) must have been there too, even though she was not in the prison at the time concerned. However it makes very little sense to locate her marital condition in a place she does not occupy. Her marital condition does not involve just her husband – it involves both of them. If one is insistent upon assigning a location to her marital condition (and, hence, to her widowing) then it seems that one ought to include both locations, viz., her location and her spouse's location. But this, of course, amounts to denying that her widowing and her husband's dying occupy the same place, since, presumably, her husband's dying (which involves only a change in his condition of health) is not located where she is but, rather, with him alone.

On the proposed analysis the location of Xantippe's widowing is spatially discontinuous; it includes her location and Socrates' location but, presumably, not any of the areas lying in between, e.g., the road between her house and the prison. From the point of view of an advocate of the Lemmon criterion, this presents a problem, since the individuality of the event was supposed to derive from the unity of the space-time region involved. However it is not a difficulty for my account; for on my account, the individuality of events does not depend upon the region of space-time involved. Still the question arises: Independently of concerns about what makes an event an individual, do we really want to countenance spatially discontinuous events?

As Davidson has pointed out, one of the puzzling features of events is that many of them seem to be spatially discontinuous.[36] Some examples are: a drought which skips over certain regions of a country, a war which doesn't include the locations of neutral countries, a graduation ceremony which is moved indoors because of rain, a plague which

isn't present in uninhabited areas. In this light it seems that one test of the adequacy of an account of identity conditions for events is that it be able to satisfactorily explain the apparent discontinuity of so many events.

My account of events can readily explain why some events are spatially discontinuous. On my view, the particularity of events derives from the individuality of concrete changes, which, in turn, derives from the individuality of concrete phases and times. Many of the concrete phases we pick out are spatially discontinuous entities. The condition of health of a populace, for example, does not include uninhabited areas. Likewise the condition of the U.S. economy does not include undeveloped wilderness regions. Concrete phases simply do not occupy space in the same fashion as ordinary, everyday physical objects. Not only can different concrete phases be in the same place at the same time but the same concrete phase can be in different places at the same time. But this does not make them any less individuals. Indeed the condition of the U.S. economy is just as unique and unrepeatable (no other country can have it) as Ronald Reagan. Granting this, it is hardly surprising that many events appear to be spatially discontinuous; for by hypothesis, an event is nothing more nor less than the time-ordered exemplification of differing states by the same concrete phase. Thus one should not expect to find a recession in the middle of Death Valley or Xantippe's widowing along the road between her house and the prison where Socrates died. In short, the reason why events such as recessions, widowings, and plagues appear to be spatially discontinuous is because they are spatially discontinuous. Insofar as the concrete phases which constitute them are spatially discontinuous, the events are spatially discontinuous too.

No philosophical account of events would be complete without an analysis of the death of Julius Caesar. This is a case which radically divides the intuitions of philosophers. The question is: Is Brutus' stabbing of Caesar the same event as Brutus's killing of Caesar?

According to Kim these are different events since many stabbings are not killings.[37] Indeed that very stabbing might have failed to be a killing had Caesar been immediately rushed to a modern trauma center. In such circumstances we would have denied that there had been a killing but not denied that there had been a stabbing. Thus it seems we have two different events here. Yet as Davidson points out, nothing would have been different about what Brutus actually did.[38] If events

really are concrete individuals, how can the very same act done by the very same person at the same time and place be a killing in one case and not a killing in the other? In this light it seems that we have just one event. So how do we resolve this dilemma? Is Brutus's stabbing of Caesar the same event as Brutus's killing of Caesar?

Because the terminal states involved are different, the event of Brutus's stabbing of Caesar must, on my account, be judged different from the event of Brutus's killing of Caesar. A killing terminates in an absence of life. If there is no absence of life there is no killing. In contrast a stabbing terminates in a puncture wound, or wounds. Puncture wounds are not the same as absences of life. Hence no event of a stabbing is identical with an event of a killing. Although the killing of Caesar began at the same time as the stabbing (and, perhaps, even ended at the same time), it terminated in a completely different state. In short, what makes the killing of Caesar a different event from the stabbing of Caesar is not, as Kim suggests, that that particular stabbing might have failed to be a killing (had the medics arrived in time) but, rather, that killings and stabbings are different sorts of changes. Were the universe such that a stabbing always resulted in a killing, it would still be true that the killing of Caesar is a different event from the stabbing of Caesar.

So what about Davidson's objection that the killing of Caesar is over with the stabbing because that action (Brutus's stabbing of Caesar) resulted in Caesar's death?[39] The force of this objection appears to rest on an ambiguity in the use of the expression "the killing of Caesar". It is sometimes used to designate the event which was the cause of Caesar's death and other times used to designate the complex event which consists of both the event of the stabbing of Caesar and the event of the death of Caesar. Used in the first way, what Davidson says is unobjectionable. Granting that the cause of Caesar's death is the stabbing of Caesar and that the expression "the killing of Caesar" refers to the cause of Caesar's death, it straightforwardly follows that the killing of Caesar is the same event as the stabbing of Caesar. However this was not the use of the expression I had in mind when I spoke of the event of the killing of Caesar being different from the event of the stabbing of Caesar. What I had in mind was the second use of the expression.

As an example of the second way in which the expression "the killing of Caesar" can be used, imagine that some medics had arrived on the

scene just as Brutus and his cohorts were fleeing. It would have made perfectly good sense for them to tell a panicked and confused bystander that they were trying to stop (not abet) the killing of Caesar; for without Caesar's death, there would have been no killing. But it would not have made sense for them to claim that they were trying to stop the stabbing of Caesar. In other words, one can make sense of the claim that someone is trying to stop the killing of Caesar even though the stabbing of Caesar is already over with and done, which means that the expression "the killing of Caesar" has a legitimate interpretation in which it does not refer to just the event of the stabbing of Caesar.

Will Davidson's objection work against this interpretation of the expression "the killing of Caesar"? No. Although it is true that Brutus's stabbing of Caesar caused Caesar's death, the killing of Caesar (*qua* complex event) is not over with the stabbing; there is more to come, viz., the death of Caesar. Furthermore even supposing that Caesar expired with the last puncture wound, it still wouldn't follow that the killing of Caesar is the same event as the stabbing of Caesar. For as we have seen, the killing of Caesar terminates in a different state than the stabbing of Caesar, which, on my view, is sufficient to demonstrate that they are different events. Indeed had the termination of the killing of Caesar been simultaneous with the termination of the stabbing of Caesar, we would have had just another case of two different events occupying the same place at the same time.

In summary, construed as the event which begins with Caesar's stabbing and ends with Caesar's death, the killing of Caesar is not the same event as the stabbing of Caesar. It is a composite event which includes two causally related subevents, namely, an event of stabbing and an event of death. Without the death, there can be no event of a killing, even supposing that actions of that kind normally result in death. Without the stabbing that particular killing would not have occurred, even supposing that Caesar had expired at the appointed time from unrelated health problems. So while it may well be true that the cause of Caesar's death was his stabbing (and even that the killing of Caesar was over at the time the stabbing was over), it simply does not follow that the killing of Caesar is the same event as the stabbing of Caesar.

4.

In summary, in accord with Lombard I take events to be first and foremost changes. On my account, however, events are not individu-

ated in terms of physical objects. Similarly Bennett and I both agree that events involve particularized properties, however I do not identify events with particularized properties, nor do I individuate events in terms of space-time locations. Rather I take particularized determinable properties (concrete phases) to be the basic individuals in terms of which events are to be individuated. On my view concrete phases are, like physical objects, enduring and unrepeatable denizens of physical reality. But they do not extend in space in the same way in which physical objects extend in space. Different concrete phases can occupy the same place at the same time and the same concrete phase can be in two different places at the same time without occupying any of the places in between. It is this feature of concrete phases which allows us to resolve a number of long standing puzzles concerning the individuation of events, e.g., that different events can be in the same place at the same time, that some events are spatially discontinuous.

The theoretical utility of concrete phases is not, however, limited to resolving puzzles about events. As I have argued, both our technical scientific talk and our ordinary, everyday talk about change is remarkably consistent with the notion that concrete phases are the proper subjects of change. Moreover the notion that events are constituted by concrete phases allows us to make sense of the description and redescription of events which goes on in scientific explanation and action theory. Because concrete phases come under different descriptions, their changes can be redescribed in many different ways. For example, we can describe the cause of the expansion of a piece of copper in terms of a change in the temperature of the copper or a change in the mean kinetic energy of the copper; for according to current physical theory, temperature is nothing more nor less than mean kinetic energy. Depending upon our purposes, interests and background, one of these descriptions may have much greater explanatory value than the other. Nevertheless both descriptions pick out the same phenomenon, viz., the concrete change which caused the expansion of the copper. In short, there are many good reasons for taking concrete phases seriously as part of the basic furniture of the world.[40]

NOTES

[1] Davidson has adumbrated his theory of events in a number of publications, most of which have been reprinted in his (1985).

[2] Of course the reasons just canvassed for accepting an ontology of events are not

conclusive. For it has not been shown that it is *impossible* to reinterpret causation, explanation and action theory, or to accommodate the adverbs in predicate logic, without an appeal to concrete events.

[3] I use the expression "identity conditions" in its metaphysical, rather than epistemological, sense. That is to say, I do not have in mind criteria for judging when two events are identical, rather, I have in mind criteria for individuating events (for specifying characteristics unique to events). For more on this distinction see Brand (1977).

[4] Quine (1969), p. 23.

[5] See 'The Individuation of Events', in Davidson (1985), p. 179.

[6] See, for instance, M. Beardsley (1975) and N. Wilson (1974).

[7] In his (1985), p. 166.

[8] Lemmon (1967).

[9] Op. cit., in Davidson (1985), p. 178.

[10] Kim (1973).

[11] Davidson has argued (op. cit., p. 173) that an adequate account of events needs to accommodate events which are not constituted by physical objects and Brand (1977) has directly criticized Kim's account for failing to accommodate such events.

[12] Strawson (1979), pp. 59–86.

[13] For example, Quine (1985), p. 167.

[14] For example, E. LePore (1985), pp. 160–61.

[15] Kim (1966, p. 222) explicitly includes static states and conditions under the rubric "event". Similarly Brand, an advocate of a modified version of the Lemmon criterion, has remarked, in his (1977, p. 335), that some events are "unchanges".

[16] Lombard (1986).

[17] Lombard (1986), p. 178.

[18] See Aristotle's *Physics* (Bk. VI, Ch. 6) as translated in (1970), p. 328.

[19] Johnson (1921).

[20] I had a difficult time coming up with a natural term for those existential conditions which are constituted by determinable properties. I finally chose the term "phase" because of its association with matter as having three different phases (solid, liquid and gas), each of which can, itself, be further specified.

[21] For a fairly detailed exploration of this possibility see Armstrong (1980), Vol. II, pp. 117–20.

[22] Particularized properties are also known as "unit properties", "cases", and "property-instances". For a detailed discussion of the nature of particularized properties see Armstrong (1980), Vol. I, Ch. 8.

[23] Bennett (1988), p. 88.

[24] Although Bennett's book is better known, I suggested that particularized properties be used to individuate events earlier, while a CSLI (Center for the Study of Language and Information) postdoctoral student at Stanford University: the preliminary results of my investigations were published in a CSLI report (1987). The current paper represents the flowering of those ideas into a full-fledged theory of events. As will be discussed in Section 3, although Bennett and I both use particularized properties to analyze events, our actual accounts differ substantially.

[25] If Descartes is right about minds being essentially nonspatial: See 'Mediation VI' as translated in (1986).

[26] To repeat, it is important to keep in mind the difference between being able to *tell* when

two individuals are different and being able to *ontologically distinguish* two individuals as different individuals. It does not follow from the fact that we often (or even always) distinguish different instances of temperature in terms of differences in physical objects or spatiotemporal locations, that the physical objects or spatiotemporal locations involved are more basic than the instances of temperature concerned.

[27] One possibility might be to construe spatiotemporal locations as instances of spatiotemporal properties and physical objects as instances of complexes of higher order properties examplified by spatiotemporal locations. In any case, the view that particularized properties are the basic stuff of the universe (so-to-speak) is not unprecedented; among the philosophers who have defended it are G. F. Stout (1923) and D. C. Williams (1953).

[28] For the sake of simplicity, I have assumed that basic changes are binary-constituted by pairs, as opposed to, say, triples or quadruples, of concrete states. On this view, changes involving temporally extended sequences of differences in state, e.g., the warming of a tea kettle, are composites of basic binary changes. However, in the event that I am wrong about this, (D4) can readily be extended to include n-ary changes as basic.

[29] There is a sense in which (D4) makes unchanges degenerate events. Accordingly if one is determined to include unchanges as events all one has to do is to drop condition (iii). However as we shall see in Section 3, condition (iii) is useful for the purpose of handling some traditionally thorny cases of event identity.

[30] Russell (1903), p. 469.

[31] See my (1990).

[32] For example, see R. Abraham and C. Shaw (1984), Part I.

[33] This sentence is a close variation on one proposed by Barbara Partee as a challenge to Montague semantics: for a discussion of it see Montague (1974, pp. 268–69).

[34] Bennett (1988), p. 88.

[35] M. Beardsley (1975, 269), for examle, has argued this.

[36] Op. cit., in Davidson (1985), pp. 175–77.

[37] Kim (1966), pp. 295–311.

[38] Op. cit., in Davidson (1985), p. 171.

[39] Ibid.

[40] I would like to thank the Center For The Study of Language and Information at Stanford University for supporting the initial stages of this research. I would also like to thank Georges Rey for detailed and helpful comments on the first draft of this paper.

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