DID SOCRATES DIE?
A NOTE ON THE MOMENT OF CHANGE

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1. The problem

In *Against the Physicists* (II, 346-7), Sextus Empiricus presents the following argument (which he attributes to Diodorus Chronus):

> If Socrates died, he died either when he was living or when he was dead. But he did not die while living; for assuredly he was living, and as living he had not died. Nor when he died; for then he would be twice dead. Therefore, Socrates did not die.[1]

The conclusion D is a necessary consequence of the premises A-C:

(1) **A:** If Socrates died, either he died when he was alive or he died when he was dead.
B: Socrates did not die when he was alive.
C: Socrates did not die when he was dead.
D: ∴ Socrates did not die.

Since we know that the conclusion is false, something must be wrong with the premises. But what is wrong with them exactly? This question is an instance of the *problem of the moment of change*: when an event occurs which involves a change from a state φ to a state not-φ, when does the change occur?[2]

In section 2, I present a way of rejecting Sextus' argument inspired by a view on change expressed by Aristotle. In section 3, I point out some problems for the proposal. In sections 4-5, I consider a different way of rejecting the argument, based on Kamp's (1980) logic of change. In section 6, I raise some difficulties for the Kampian solution. In section 7, I go back to the Aristotelian solution and outline a different way of spelling it out, which I argue to be immune to the objections raised in section 3. Finally, in section 8, I discuss some further objections, in particular I address a problem

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[1] Sextus Empiricus [1936]

[2] The first known instance of this problem is in Plato's *Parmenides* 156c-157b and concerns the change from rest to motion.

raised for my proposal by Altshuler and Schwarzschild's (2013) account of cessation implicatures.

2. An Aristotelian solution

In the VI book of the *Physics*, Aristotle claimed that change cannot happen at an instant (a "now", in Aristotle's terminology) and that it can only happen at a period (a non instantaneous interval). By Aristotle's reasoning, when x changes from a state A to a state B, at the beginning of the change x is in state A and at the end of the change x is in state B. Thus, the change must span over an interval at the initial endpoint of which x is in state A and at the final endpoint of which x is in state B.[3]

Formally, we may capture this idea by modeling change by means of the sentential operator BECOME in interval semantics:[4]

(2) $[\![\text{BECOME } \varphi]\!]_i$=1 iff there is an interval i' overlapping the beginning of i such that $[\![\varphi]\!]_{i'}$=0 and there is an interval i'' overlapping the end of i such that $[\![\varphi]\!]_{i''}$=1.

We may now represent the logical form of sentence (3) below as (4):

(3) Socrates dies (tenseless).

(4) BECOME dead(s)

By rule (2), "Socrates dies" is true at an interval only if, at the beginning of the interval Socrates is alive and at the end of the interval Socrates is dead. If this is the case, then premise A of Sextus' argument is false because it fails to consider a third possible option. According to (2)-(4), the interval at which Socrates died is neither an interval at which he was dead (since he was alive at the beginning of the interval) nor an interval at which he was alive (since he was dead at the end of the interval).

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[3]Here's Aristotle's formulation of the argument:

> ...everything that has changed from something to something has changed in a period of time. For suppose [20] that a thing has changed from A to B in a now. Now the now in which it has changed cannot be the same as that in which it is at A (since in that case it would be in A and B at once); for we have shown above that that which has changed, when it has changed, is not in that from which it has changed. If, on the other hand, it is a different now, there will be a period of time intermediate between the two (*Physics*, Book VI, 237^a, 18-25).

[4]The formulation of rule (2) is from van Benthem [1983]. van Benthem attributes it to Dowty [1979]. However, although at various points in the text Dowty seems to assume (2), his formulation does not require that intervals i' and i'' overlap with i, it requires that i' precede i and i'' follow i.

3. Why the Aristotelian solution doesn't work

There are several problems with this reply to Sextus' argument. For one thing, definition (2) is known to be semantically inadequate: it makes incorrect predictions about the conditions under which natural language sentences represented via the BECOME operator are true. For example, if we represent (3) as (4), rule (2) predicts that (3) is true at an interval i which spans from the time when Socrates is born to the time when he is dead, since there is an interval overlapping the beginning of i at which Socrates is alive and an interval overlapping the end of i at which Socrates is dead. Or take an interval i at the beginning of which the light is green, then it turns red for a while, then it turns green again for a while, and so on several times, until, at the end of i, it turns red. If we represent (5) as (6), by (2) we predict that (5) should be true at i:

(5) the light turns red (tenseless).

(6) BECOME red(light)

These predictions are clearly in contrast with our intuitions.[5]

There is another reason why one might not be satisfied by the Aristotelian reply to Sextus. In a sense, the reply doesn't really answer the metaphysical query which is posed by the question "when did Socrates die?". Indeed, upon hearing the Aristotelian reply, one might ask: what happens during the interval of transition from Socrates' being alive to his being dead? Let t_j and t_k be, respectively, the initial and the final endpoints of the interval i at which Socrates dies:

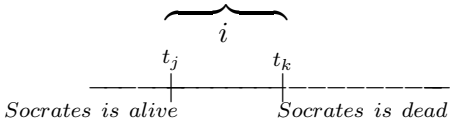

Fig. 1

[5]Perhaps I am being overconfident in making this claim. An anonymous reviewer points out that we do say things like "From the time we are born, we are dying" for dramatic effect. So, in this sense, one might say that "Socrates dies" is true at an interval that spans from the time Socrates was born to the time he was dead. Moreover, suppose that the traffic light is green for a while, then, when it should turn red, it flickers between green and red a few times due to a malfunctioning, and eventually it settles on red. One might appropriately say in this case that the light turned red. I find the latter example more convincing than the former (one often says patently false things for dramatic effect). But I agree that determining for which interval it can be appropriately asserted that someone died at that interval or that a light turned red at that interval is to some extent a context dependent matter. I think that this has to do with how we conceptualize events in different contexts. So, one way to state the semantic problems with representing change via the BECOME operator in (2) is that a purely interval-based approach fails to make this dependence on event conceptualization explicit (I come back to this in section 7). See, however, Dowty [1979] and Landman [1991] for discussion of some ways in which one may cope with these problems in an interval semantics framework.

If time (the instant structure) is dense, then the interval $i = [t_j \quad t_k]$ contains an infinite number of instants.[6] What holds at these instants? If bivalence holds for truth at an instant, then at every instant in i it is either true that Socrates is dead or false that Socrates is dead. Now, at the beginning of i it is false that Socrates is dead and at the end of i it is true that Socrates is dead. Thus, there must be an instant t_0 in i such that at any instant before t_0 it is false that Socrates is dead and at every instant after t_0 it is true that Socrates is dead. So, what happens at t_0? Is it true that Socrates is dead or is it false? On the other hand, if change from being alive to being dead is instantaneous but bivalence does not hold for truth at an instant, one might claim that at the instant of change t_0 it is neither true nor false that Socrates is dead. In any case, it is unlikely that Sextus or any metaphysician interested in the question "when did Socrates die?" would be satisfied by an answer that fails to address these issues.[7]

The defender of the Aristotelian solution might refuse to engage in this type of speculation simply by insisting that, since change never occurs at an instant, there is no instant t_0 in i such that at any instant before t_0 it is false that Socrates is dead and at every instant after t_0 it is true that Socrates is dead. She might claim that between t_j and t_k it is simply indeterminate whether Socrates is dead or alive. But is it plausible to reject the existence of instantaneous changes? Suppose the light went out suddenly, just once. On the face of it, this is an instantaneous change. And notice that, in this case as well, we may replicate Sextus' reasoning: if the light went out, it went out either when it was on or when it was out. But it did not go out when it was on, since the light would be on and out at the same time; and it did not go out when it was out, since it would have gone out twice, which was not the case. However, if the change from being on to being out is instantaneous, we cannot reject premise A′ in argument (7) by adducing as a reason that sentence (8) has the logical form in (9), which can only be true at intervals larger than instants:

(7) **A′:** If the light went out, it went out either when it was on or when it was out.
B′: The light did not go out when it was on.
C′: The light did not go out when it was out.
D′: ∴ The light did not go out.

[6]Here I am assuming, with Dowty [1979], an instant-based interval semantics in which intervals are convex (gapless) sets of instants. If intervals are primitive, density would require that $[t_j \quad t_k]$ contain an infinite number of smaller intervals, and similar questions would arise.

[7]Indeed, for many philosophers (Medlin 1963, Hamblin 1969, Sorabji and Kretzmann 1976, Chisholm 1980, Kamp 1980, Mortensen 1985, Le Poidevin 2003, Priest 2006), the problem of the moment of change is stated thus: if state s described by φ holds before an instant t_0 and state s' described by $not{-}\varphi$ holds after t_0, does s hold at t_0 or does s' hold at t_0? For a discussion of the metaphysical debate on the moment of change both in ancient and in contemporary philosophy, see Strobach [1998].

(8) The light goes out.

(9) BECOME out(light)

I won't pursue these issues any further at this point, since it seems to me that the semantic problems raised by the Aristotelian solution are best dealt with in a dynamic framework which represents change by introducing events of change in the domain of the model rather than by reconstructing change in terms of incompatible states holding at successive intervals. I'll come back to the issues of transitions and instantaneous changes in section 7. In the next three sections, I'll consider a solution to Sextus' problem built on a dynamic (event-based) theory of change. Then, I'll present a dynamic version of the Aristotelian solution.

4. Kamp's logic of change

Kamp [1980] provides a theory aimed at validating the following principle, which he calls *principle of incompatibility*:

PI. at the time of change from P to not-P neither P nor not-P holds.

The theory starts from event models for a language L whose ingredients are a set of events E, the relations of complete precedence $\prec$ and temporal overlap $\bigcirc$ between events (constrained by axioms appropriate to their intended meanings), and a partial function A_2 which maps pairs consisting of an event and an atomic sentence of L into one of four values P, F, B, C.[8] Intuitively, given an event e and a sentence s,

(10)
a. $A_2(e)(s)$=P means that s is true throughout e.
b. $A_2(e)(s)$=F means that s is false throughout e.
c. $A_2(e)(s)$=B means that e is a change from not-s to s.
d. $A_2(e)(s)$=C means that e is a change from s to not-s.

So, A_2 provides information about what is the case when an event occurs. Kamp assumes, moreover that A_2 is subject to the following *consistency requirement for overlapping events*:

(11) if events e_1, e_2 overlap and $A_2(e_1,s)$ and $A_2(e_2,s)$ are defined, then $A_2(e_1,s)=A_2(e_2,s)$.

As we will see in a moment, the consistency requirement on A_2 plays an important role in validating PI.

Kamp's event models make room for the possibility that there is some vagueness about when two changes happen. Suppose two light spots on a screen are changing color, one is changing from red to orange and the other

[8] In Kamp's paper, event models also contain a function A1 which maps events onto pairs consisting of a sentence of L and one of the values P, F, B, C. Since A1 plays no role in my discussion, I ignore it here.

from green to blue. Are these changes simultaneous or does one precede the other? Their temporal relation may be undetermined. The precedence relation $\prec$ in an event model M reflects this fact, since it may not satisfy the axiom of linearity (according to which, for each event e, e' either $e \prec e'$ or $e' \prec e$ or $e' \bigcirc e$). The vagueness of the temporal ordering is dealt with by Kamp with the familiar technique of supervaluations, by considering *completions* of the event models in which vagueness is eliminated, namely the events are ordered linearly, and by defining truth (falsity) at an event e in an event model M as truth (falsity) in all the completions of M at every instant in e. (This allows for the possibility that the exact instant at which a change takes place is indeterminate, while preserving the principles of classical logic).

Given a completion M′ of an event model, we may construct *the instant model derived from* M′ by following the Russell-Wiener method.[9] By this method, the instant model is a triple N′=<T′, $<'$, F′ >, where T′ is the set of instants constructed as maximal sets of pairwise overlapping events in M′, and $<'$ is the derived precedence relation between instants, such that $t<'t'$ iff there is an event $e \in t$ and there is an event $e' \in t'$ and $e \prec' e'$. (It may be shown that, if the set of events is linearly ordered by $\prec'$, the set of instants is linearly ordered by $<'$). Finally, F′ is a function that assigns to each instant-predicate pair of the language the set of individuals that satisfy the predicate at that instant. The predicates of the language will include both primitive predicates and predicates formed by applying the operators **B**, **C**, **F** of L′ (not to be confused with the values of the function A_2) to primitive predicates. Intuitively, given a primitive predicate Q, "**B**Q(a)" is read as "a is becoming Q" or "a is changing from non-Q to Q", "**C**Q(a)" is read as "a is ceasing to be Q" or "a is changing from Q to non-Q", "**F**Q(a)" is read as "a fails to be Q". Function F′ is defined as follows for any predicate Q (I use "a" for the denotation of "a"):[10]

(12) (i) $\mathrm{F}'(\mathrm{Q}, t) = \{a : \exists e(e \in t \wedge \mathrm{A}_2'(e, \mathrm{Q(a)}) = \mathrm{P})\}$
(ii) $\mathrm{F}'(\mathbf{F}\mathrm{Q}, t) = \{a : \exists e(e \in t \wedge \mathrm{A}_2'(e, \mathrm{Q(a)}) = \mathrm{F})\}$
(iii) $\mathrm{F}'(\mathbf{B}\mathrm{Q}, t) = \{a : \exists e(e \in t \wedge \mathrm{A}_2'(e, \mathrm{Q(a)}) = \mathrm{B})\}$
(iv) $\mathrm{F}'(\mathbf{C}\mathrm{Q}, t) = \{a : \exists e(e \in t \wedge \mathrm{A}_2'(e, \mathrm{Q(a)}) = \mathrm{C})\}$

The definition of truth at an instant for atomic sentences of the language may then be given thus:[11]

(13) a. $[\![\mathrm{Q(a)}]\!]_{N',t}=1$ iff $a \in \mathrm{F}'(\mathrm{Q}, t)$.
b. $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$ iff $a \in \mathrm{F}'(\mathbf{B}\mathrm{Q}, t)$

[9] Wiener [1914], Russell [1936].

[10] A_2' is the function that corresponds to A_2 in the completion M′ of the event model M.

[11] This is not the way Kamp states it, although it seems natural enough in his framework.

c. $[\![\mathbf{C}\mathrm{Q(a)}]\!]_{N',t}=1$ iff $a \in \mathrm{F}'(\mathbf{C}\mathrm{Q}, t)$
d. $[\![\mathbf{F}\mathrm{Q(a)}]\!]_{N',t}=1$ iff $a \in \mathrm{F}'(\mathbf{F}\mathrm{Q}, t)$

The truth of complex sentences is the familiar one from tense logic, for example the clause for negation is the following:

(14) a. $[\![\neg\varphi]\!]_{N',t}=1$ iff $[\![\varphi]\!]_{N',t}=0$.

According to (12)-(13), an individual is changing from not-Q to Q at an instant iff there is an event belonging to that instant which is a change from not-Q to Q. The theory validates the principle of incompatibility, which now requires that, if a is changing from not-Q to Q (or from Q to not-Q) at an instant t, then a is neither Q at t nor fails to be Q at t:

(15) if $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$ (or $[\![\mathbf{C}\mathrm{Q(a)}]\!]_{N',t}=1$), then $[\![\mathrm{Q(a)}]\!]_{N',t}=0$ and $[\![\mathbf{F}\mathrm{Q(a)}]\!]_{N',t}=0$.

This result follows, since if a is changing from not-Q to Q (or from Q to not-Q) at an instant t, then, by the above definition of truth and the consistency requirement for overlapping events, for every event $e \in t$ the function A'_2 will assign to each pair $< e, \mathrm{Q(a)}>$ in its domain the value B (or C). Thus, no event $e \in t$ is such that the function A'_2 will assign the value P or the value F to $< e, \mathrm{Q(a)}>$, which means that both Q(a) and FQ(a) are false at t.[12]

Finally, notice that, by the way the definition of truth is set up in the completions of event models, it follows that the principle of bivalence holds, namely:

(16) $[\![\varphi]\!]_{N',t}=1$ or $[\![\varphi]\!]_{N',t}=0$.

5. A Kampian solution

Now, let's come back to the problem raised by Sextus' argument. Notice that the problem arises even if events are ordered linearly: the question

[12]Formally, we may prove this consequence as follows:
Show: if $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$, then $[\![\mathrm{Q(a)}]\!]_{N',t}=0$.
Proof: suppose $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$. Then, $a \in \mathrm{F}'(\mathbf{B}\mathrm{Q}, t)$. Thus, $\exists e(e \in t \wedge \mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{B})$. Thus, given that any two events in t overlap, by the principle of consistency of overlapping events every e in t is such that, if $\mathrm{A}'_2(e, \mathrm{Q(a)})$ is defined, then $\mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{B}$. Thus, given that A'_2 is a function, there is no event e in t such that $\mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{P}$. Thus, $[\![\mathrm{Q(a)}]\!]_{N',t}=0$.
Show: if $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$, then $[\![\mathbf{F}\mathrm{Q(a)}]\!]_{N',t}=0$.
Proof: suppose $[\![\mathbf{B}\mathrm{Q(a)}]\!]_{N',t}=1$. Then, $a \in \mathrm{F}'(\mathbf{B}\mathrm{Q}, t)$. Thus, $\exists e(e \in t \wedge \mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{B})$. Thus, given that any two events in t overlap, by the principle of consistency of overlapping events every e in t is such that, if $\mathrm{A}'_2(e, \mathrm{Q(a)})$ is defined, then $\mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{B}$. Thus, given that A'_2 is a function, there is no event e in t such that $\mathrm{A}'_2(e, \mathrm{Q(a)})=\mathrm{F}$. Thus, $[\![\mathbf{F}\mathrm{Q(a)}]\!]_{N',t}=0$.

By an analogous reasoning, it is possible to show that, if $[\![\mathbf{C}\mathrm{Q(a)}]\!]_{N',t}=1$, then $[\![\mathrm{Q(a)}]\!]_{N',t}=0$ and $[\![\mathbf{F}\mathrm{Q(a)}]\!]_{N',t}=0$.

the argument raises is not whether the time of the change (the death of Socrates) can be determined exactly with respect to the time of other events, but rather, assuming that it can be so determined, whether it overlaps with the state of Socrates' being alive or with the state of Socrates' being dead. Thus, in discussing how Kamp's theory may be applied to the problem, we may concentrate on the extensions M' that obey linearity.

It should be kept in mind that, although Kamp's theory suggests a way to cope with the problem posed by Sextus' argument, the theory was not meant to apply to natural languages directly, so my discussion here may introduce assumptions that Kamp does not endorse.[13] Suppose we use the predicate operator **B** to describe the logical form of sentence (3):

(3) Socrates dies (tenseless).

(17) **B**dead(s)

By Kamp's semantics, an instant at which (17) is true is neither a time at which Socrates is dead nor a time at which Socrates fails to be dead (although it is a time at which it is not the case that he is dead). If being alive means the same as failing to be dead, then we may reject premise A of Sextus' argument, since this premise fails to consider a possible option, namely that Socrates died at a time when he neither was dead nor failed to be dead, this being the time of change (alternatively, if being alive means that it is false that Socrates is dead, one may reject premise B, since the time of change is a time at which it is false that Socrates is dead).

So, the Kampian solution, like the Aristotelian solution, allows one to reject premise A (assuming that being alive means the same as failing to be dead). Moreover, as Landman [1991] points out, the Kampian solution avoids the semantic problems of the Aristotelian solution. To see why this is the case, we may reason as follows. In Kamp's semantics, truth is defined at an instant, while in the Aristotelian solution we assumed that truth was defined at intervals, so a direct comparison requires that we supplement Kamp's theory by allowing sentences to be true at intervals constructed as gapless sets of instants. Suppose that a sentence φ is true at an interval i iff there is an event e that goes on at every instant in i such that e is of the type required by $\mathrm{A}'_2(e, \varphi)$. Now, suppose (17) is true at i. Then, a change from Socrates' not being dead to Socrates' being dead goes on at every instant in i. However, by the principle of incompatibility, which is validated by Kamp's

[13] Indeed, Kamp [1980] states at the end of the paper:

> This brings me to the last major issue which must eventually be discussed but about which too I have been almost entirely silent: the means of expressing change that are available in natural languages, in particular English. This is a complex problem, and the little that I may have achieved in this first part of the paper can at best serve as a formal setting in which various aspects of that problem might be more fruitfully discussed than would be possible without it. (p. 178)

semantics, any instant at which (17) is true is neither an instant at which Socrates is alive (fails to be dead) nor an instant at which Socrates is dead. So, (17) is not true at any instant at which Socrates is an infant (since he is alive at any such instant), thus (17) cannot be true at any interval which includes such an instant. By the same reasoning, (5), now translated as (18) below, could not be true at any interval during which the light is green, then red, then green, then red again. The reason is that such an interval would contain instants at which the light is red and fails to be red (is green), which, again, is excluded by the principle of incompatibility.

(5) the light turns red (tenseless).

(18) **B**red(light)

Notice that the theory is compatible with the existence of instantaneous changes, indeed it is crafted to account for them. The additional constraint in (19) on event models states that all changes from one state to its opposite are instantaneous events, in the sense that they are not divided by other events:[14]

(19) $(\mathrm{A}_2(e)(\varphi)=\mathrm{B} \vee \mathrm{A}_2(e)(\varphi)=\mathrm{C}) \rightarrow \neg\exists\, e' \exists\, e'' \,(e \bigcirc e' \wedge e \bigcirc e'' \wedge e' \prec e'')$

6. Problems with the Kampian solution

Although the Kampian solution avoids the problems raised for the Aristotelian solution, it seems to me that one might question both an aspect of the theory of change on which it is based and the applicability of the theory to Sextus' argument.

Kamp's theory of change distinguishes between not being the case that an object a is Q from being the case that a fails to be Q. In pretheoretical terms, we may understand this difference by contrasting two intervals i and i' during which the following happens:

> Socrates is out throughout i.
> Socrates is out only for part of i'.

At interval i, Socrates fails to be in, since throughout i it is false that Socrates is in; for the same reason it is not the case that Socrates is in at i. On the other hand, at interval i' it is not the case that Socrates is in, since Socrates is out for part of i', but it is false that Socrates fails to be in, since Socrates is in for part of i'.

One might dispute that the English predicate "fails" and the English connective "it is not the case that" appropriately convey the distinction, but Kamp is not committed to say they do. The above example may simply be used to make intuitively clear what we mean when we introduce a distinction between failing to be and not being the case. But the distinction only makes

[14]Instantaneity in Kamp's theory need not be absolute: an event e's being instantaneous depends ultimately on how the set of events in an event model is specified, which reflects the conceptual scheme adopted in singling out events.

sense until we consider intervals larger than instants, since at such intervals an object may be in a state for part of the interval and be in an incompatible state for another part of the same interval. It makes no sense to assert that it is not the case that a is Q at an instant t, while denying that a fails to be Q at t, since one cannot distinguish parts of t at which a is Q and parts of t at which a is in a state incompatible with Q. However, this is not what Kamp's theory allows us to conclude. Take the example of the light's going out suddenly. Assuming that instant t is the time of change, (20) is true at t:

(20) **B**out(light)

By Kamp's logic, it follows that t is an instant at which it is not the case that the light is out, but it is false that the light fails to be out. So, it seems that the theory forces us to make a distinction in cases that go beyond the intuitions that motivate its introduction.[15]

Now, let's turn to the objection concerning the applicability of the theory to Sextus' argument. It seems to me that, contrary to what we assumed in applying Kamp's theory to reject the first premise of the argument, (17) is not a correct logical form for sentence (3):

(3) Socrates dies (tenseless).

(17) **B**dead(s)

Here's why. When we assert that Socrates died, we assert that Socrates is dead at the end of the dying event. If the assertion is true, the state of Socrates' being dead kicks in at the end of the event of Socrates' dying, not after it. Indeed, it makes no sense to say that Socrates died before he was dead. So, English sentence (21) is true iff at some time in the past there is an event at the end of which Socrates is dead:

(21) Socrates died.

But (21) is true iff at some time in the past there is an event of the type described by (3).[16] So, it seems reasonable to conclude that

(22) sentence (3) is true at a time iff an event at the end of which Socrates is dead occurs at that time.

Now, the truth of (17) does not require this. In order for (17) to be true at an instant, an event of Socrates' becoming dead must belong to that instant. Since by (19) an event of change is instantaneous, there is a unique instant to which an event of change belongs, which is the instant at which

[15]Of course, Kamp may question the example I used to provide an intuitive understanding of the distinction between not being the case and failing to be. In this case, however, some alternative way to motivate the distinction intuitively should be provided.

[16]I presented some arguments in favor of this conclusion in Zucchi [1999].

we may say that the event occurs. An event of Socrates' becoming dead in Kamp's theory is an event that only occurs at instants at which Socrates neither is dead nor fails to be dead. The implication *if there is an event of Socrates' becoming dead, then a state of Socrates' being dead holds at some point* is secured by an independent principle which requires that an event of a's becoming Q be preceded by a state of a's failing to be Q and followed by a state of a's being Q (and that an event of a's becoming not-Q be preceded by a state of a's being Q and followed by a state of a's failing to be Q). This is Kamp's *principle of completed change* (the following is the part that concerns the change from not-Q to Q):

(23) suppose $A_2(e)(Q(a))$=B; then there is an e_1 such that $e_1 \prec e$ and $A_2(e_1, Q(a))$=F and there is an e_2 such that $e \prec e_2$ and $A_2(e_2, Q(a))$=P.

Thus, an event of Socrates' becoming dead, in Kamp's sense, can only occur *before* Socrates is dead. So, if (22) is true, (17) does not describe the meaning of (3) correctly and (21) is not correctly analyzed as (24):

(24) PAST **B**dead(s)

What (24) says is that there is a past time at which Socrates *was becoming* dead. What (21) says is that there is a past time at which Socrates *became* dead.[17]

I should stress that this is not an objection to Kamp's theory (Kamp is careful in glossing the **B** operator as "–is becoming..." and not as "–becomes..."). The objection is to the application of Kamp's theory that consists in representing the meaning of (3) by (17) and the meaning of (21) by (24). However, if the objection is correct, the Kampian solution to the problem posed by Sextus' argument doesn't work: the problem posed by the argument concerns whether the premises A-C are true, and A-C make use of the English predicate "die".

Let's take stock. The Kampian solution requires us to accept that (a) it makes sense to distinguish between not being the case that a is Q at an instant and a's failing to be Q at the same instant. Moreover, it requires that (b) we give up the intuition, often taken for granted in event semantics, that, if Socrates dies, he is dead at the end of the dying event and not after it.[18] If we are willing to accept (a) and (b), then perhaps there is no more

[17]Here I am not suggesting that Kamp's predicate operator **B** is appropriate to represent progressive predicates like "dying". Notice that, one may truthfully assert that Socrates is dying while Socrates is still alive. So, "**B**dead(s)" cannot mean the same as "Socrates is dying", since "**B**dead(s)" in Kamp's theory is false at instants at which Socrates is alive (fails to be dead).

[18]This assumption is made explicit, for example, in Parsons [1989, p. 219], Parsons [1990, p. 119], Higginbotham [2000b, p. 37], Higginbotham [2000a, p. 117], [Rothstein, 2004, p. 155]. Parsons allows both complete and incomplete events in the denotation of

to say about the problem raised by Sextus. In the remaining part of this paper, I'll present a solution that keeps the intuition and see where it leads.

7. A revised Aristotelian solution

The above observations concerning the type of events described by (3) and (21) bring us back to the intuition underlying the Aristotelian solution. In event talk, the intuition may be expressed thus: an event of x's dying is neither an event throughout which x is dead, since it has a part during which x is not dead, nor an event throughout which x is not dead, since at the end of the event x is dead. In the interval semantics approach in which the Aristotelian solution was couched, change was described via the BECOME operator. Once events are introduced, the natural transition is to analyze change in terms of events of becoming, as we saw in Kamp's theory. Let's follow this lead, by assuming that events of dying are a kind of becoming events. However, unlike Kamp, let's assume that the patient is dead at the end of events of this kind. More precisely, let's adopt the following Davidsonian translations (clause $e \supset\subset s$ means that the last moment at which e goes on is the first moment at which s holds, for short e and s *abut*):[19]

(25) die
$\lambda x \lambda i \lambda e\ \exists s\ (become(e, s, x)\ \wedge\ occur(e, i)\ \wedge\ dead(s, x)\ \wedge\ e \supset\subset s)$

(26) Socrates dies (tenseless)
$\lambda e \lambda i\ \exists s\ (become(e, s, Socrates)\ \wedge\ occur(e, i)\ \wedge\ dead(s, Socrates)\ \wedge\ e \supset\subset s)$

(27) Socrates died
$\exists e \exists i \exists s\ (i < now\ \wedge\ become(e, s, Socrates)\ \wedge\ occur(e, i)\ \wedge\ dead(s, Socrates)\ \wedge\ e \supset\subset s)$

Let's assume, moreover, that an event of x's becoming dead satisfies the following principles, which make sure that the state of x's being dead does not precede the last moment of the event of x's becoming dead[20] and that the initial moment of the event of x's becoming dead is a time at which the state of x' being alive holds ($start(e)$ denotes the first moment of the interval at which e occurs and $end(e)$ denotes the last moment of that interval):

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the predicate "die"; if the events are complete, however, the patient is dead at the end of the event.

[19]Clause (25) reflects the view that events in the extension of the English predicate "die" are *completed events*, as argued in Zucchi [1999], and also in Higginbotham [2004].

[20]Translation (25) is not sufficient to guarantee that this condition is met, since a state may be a proper part of another state of the same kind. This is why we need to add (28), if we want to exclude that the state of being dead precedes the last moment of the becoming dead event.

(28) $\forall e\ \forall s\ \forall x\ \forall i\ ((become(e,s,x)\ \wedge\ occur(e,i)\ \wedge\ dead(s,x))\ \rightarrow\ \neg\exists s'\exists i'(dead(s',x)\ \wedge\ hold(s',i')\wedge\ i'<end(e)))$

(29) $\forall e\ \forall s\ \forall x\ \forall i\ ((become(e,s,x)\ \wedge\ occur(e,i)\ \wedge\ dead(s,x))\ \rightarrow\ \exists s'\exists i'(alive(s',x)\ \wedge\ hold(s',i')\wedge\ i'=start(e)))$

Finally, let's assume that, if a state holds at an interval, it holds at all subintervals of that interval:

(30) $\forall s\forall i(hold(s,i)\rightarrow\forall i'(i'\subset i\rightarrow hold(s,i')))$

This type of analysis of change has been considered before in the literature, in particular Parsons [1990, p. 119] uses similar logical forms to analyze inchoatives. Now, let's assume the following translation for the sentence negated by premise B of Sextus' argument:[21]

(31) Socrates died when he was alive
$\exists e\ \exists i\ \exists s\ (i<now\ \wedge\ become(e,s,Socrates)\ \wedge\ occur(e,i)\ \wedge\ dead(s,Socrates)\wedge e\supset\subset s\wedge\exists s'\ \exists i'\ (alive(s',Socrates)\wedge hold(s',i')\wedge i\subset i'))$

By (31) the event of Socrates' becoming dead is required to occur at an interval included in an interval at which the state of Socrates' being alive holds. Given that Socrates is dead at the end of the event of Socrates' becoming dead, this requirement cannot be met. So premise B is true. Given principle (29), a similar reasoning explains why premise C is true. But premise A is false since a true alternative is missing, the alternative in (32):[22]

(32) Socrates died when he was neither alive nor dead
$\exists e\ \exists i\ \exists s(i<now\ \wedge\ become(e,s,Socrates)\ \wedge\ occur(e,i)\ \wedge\ dead(s,Socrates)\wedge e\supset\subset s\wedge\sim\exists s'\exists i'\ (alive(s',Socrates)\wedge hold(s',i')\ \wedge\ i\subset i')\ \wedge\ \sim\exists s''\exists i''\ (dead(s'',Socrates)\ \wedge\ hold(s'',i'')\ \wedge\ i\subset i''))$

This alternative is true for the following reasons: given that the event of Socrates' becoming dead abuts a state of Socrates' being dead, the interval i at which the event of Socrates' becoming dead occurs is such that there is no interval including i at which a state of Socrates' being alive holds; moreover, given that, by principle (29), the initial moment of i is a time when Socrates is alive, there is no interval including i at which a state of Socrates' being dead holds.

[21] See Parsons [1980] for a way of deriving (31) compositionally.

[22] The English sentence in (32) seems to have a paradoxical flavor, perhaps because it suggests that there is an instant at which Socrates is neither alive nor dead. The true missing alternative, according to the account I am considering, is not this, but one which may be less concisely expressed in English by saying that Socrates died at an interval i such that he was neither alive throughout i nor dead throughout i.

Ok, but why is this any better than the Aristotelian solution presented in section 2? What does the rephrasing of the Aristotelian solution in terms of events and states buy us? One source of trouble for the earlier formulation was this: it incorrectly predicts that (3) is true at an interval i which spans from the time Socrates is born to the time Socrates is dead.

(3) Socrates dies (tenseless).

Moreover, the earlier formulation of the Aristotelian solution incorrectly predicts that (5) is true at an interval i at the beginning of which the light is green for a while, then it turns red for a while, then green again, and so on several times, until, at the end of i, it turns red.

(5) the light turns red (tenseless).

In the revised solution, these problems are not eliminated, but moved to a different level. Why doesn't an event of x's dying (normally) span over the entire life of x? Why can't an event of the light's turning red be made up by an event of the light's turning green, followed by an event of the light's turning red, followed by an event of the light's turning green, followed by an event of the light's turning red again? These questions have to do with how we conceptualize dying events and turning-red events. It is not the task of a truth-conditional semantics to tell us what kind of thing an event of dying is as it is not the task of a semantic theory to tell us what kind of thing a man is. These are tasks for a theory of concepts. Semantic theories do rely on the assumption that speakers possess some concept of what a man is and some concept of what an event of dying is and associate these concepts to the predicates "man" and "die", but they do not try to define these concepts. The logical forms in (25)-(27) as well as the principles in (28)-(29) are not meant to define what an event of x's dying is, they are not necessary and sufficient conditions for an event to be an event of dying. They help us to explain certain necessary consequences of sentences like (3) by making some necessary features of events of dying explicit, but ultimately answering the question "what is an event of dying?" is not the task of a truth-conditional semantics. The logical forms in (25)-(27) explain under what conditions (3) is true by relying on the prior understanding of what it means for an event to be an event of x's becoming dead. The problem with the earlier version of the Aristotelian solution is that it tries to explain under what conditions (3) is true by relying on the prior understanding of what it means for incompatible states to hold at an interval: apparently, this is not enough.[23] Of course, it may very well be the case that, in order to solve the problem posed by Sextus' argument, one cannot forgo the task of analyzing what an event of dying is or of delving deeper in the metaphysics of events.

[23]Or at least it's hard to do. See, however, the discussion in Dowty [1979] and Landman [1991] for some ways of avoiding the problems arising for the semantics of the BECOME operator.

The bet of the revised Aristotelian solution, however, is that, in order to block Sextus' argument, we only need the assumptions in (25)-(30).

Let's now turn to the other objections against the earlier version of the Aristotelian solution. One objection was that it fails to explain what happens during the transition from being alive to being dead. A related objection was that the theory fails to acknowledge the existence of instantaneous changes and, for this reason, fails to block other versions of Sextus' argument like the one in (7). In fact, I think that both objections are misplaced, and the revised solution helps us to explain why.

Assumptions (25)-(29) commit one to the view that, if i is an interval at which x dies, x is alive at the initial moment of i and x is dead at the final moment of i. They also commit one to the view that this final moment of i is the first moment at which x is dead. Now, if time (the point structure on which the interval structure is based) is discrete, interval i at which the event of Socrates' dying occurs may consist only of the moments t_j and t_k:

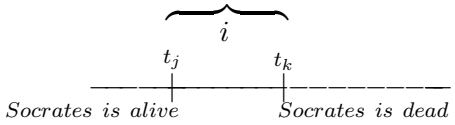

Fig. 1

On the other hand, if time is dense and bivalence holds, the revised solution requires that Socrates be alive at every instant in the interval $[t_j \quad t_k)$, namely that Socrates be alive at t_j and at every instant following t_j and preceding t_k:

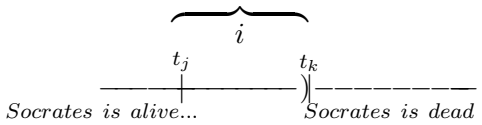

Fig. 2

In this case, the moment of change from being alive to being dead, understood as the instant before which Socrates is alive and after which Socrates is dead, is an instant at which Socrates is dead (t_k). So, the Aristotelian solution is not reticent about what happens during the transition from being alive to being dead. Once it is combined with some assumptions about the structure of time, it also yields an account of what happens during the transitions.

This also shows that the revised Aristotelian solution is compatible with the existence of instantaneous changes, in the sense that it allows the type of abrupt discontinuities in Fig. 2, where there is an instant before which Socrates is alive and after which Socrates is dead. The claim of the revised theory is simply that this instant is not a time at which what we call events of

dying in English occur.[24] The same strategy may be used to block argument (7):

(7) **A′:** If the light went out, it went out either when it was on or when it was out.
B′: The light did not go out when it was on.
C′: The light did not go out when it was out.
D′: ∴ The light did not go out.

The change from the light's being on to the light's being out may be instantaneous in the sense that there is an instant before which the light is on and after which the light is out. However, what we call events of the light's going out are not events occurring at an instant. The sentence "the light went out" describes an event at the beginning of which the light is on and at the end of which the light is out. The interval at which this event occurs is neither an interval at which the light is on (since at its final endpoint the light is out) nor an interval at which the light is out (since at its initial endpoint the light is on). So, premise **A′** is false, because, at the interval at which the light went out, the light was neither on nor out.

8. Some further objections

The revised Aristotelian solution claims that "die" is not a predicate of instantaneous events, though there may be instantaneous changes occurring during the non instantaneous intervals at which events of dying occur. One might claim that this is indeed correct for "die", since after all one might truthfully assert (33), which suggests that dying is no punctual matter:

(33) Socrates was dying.

However, the revised theory is also assumed to block arguments like (7) above, and we do not normally describe situations in which the light went out suddenly by saying "the light was going out". Moreover, one might truthfully assert (34):

(34) Socrates died at 5 pm.

The revised theory may claim that in (34) the punctual *at*-phrase refers to the final moment of the dying event. However, notice that one cannot truthfully assert (35):

[24] Is there a way of weakening the ontological commitment of the revised theory further to allow an instantaneous moment of change preceding t_k at which **PI** holds, namely at which Socrates is neither dead nor fails to be dead? Suppose t_0 were such an instant. Since t_0 is the moment of change, Socrates is alive before t_0 and dead after t_0. Then, if time is dense, there is an instant between t_0 and t_k at which Socrates is dead. So, supposing that a moment like t_0 exists would require to give up principle (28). However, under the revised theory, this would have the undesirable consequence that one may die while being already dead.

(35) ?? Mary built a bookcase at 5pm.

So, the question arises, if events of dying or of the light's going out are in fact protracted events, like events of building a bookcase, how come one can assert truthfully that they occurred at 5pm, while one cannot assert truthfully that bookcase building events occurred at 5pm?

The ability to occur with punctual time adverbs like "at 5pm", the reluctance to occur in the progressive, together with other properties (for example the ability to occur with predicates like "finish") have been traditionally used to identify the class of natural language predicates which Vendler [1957, 1967] calls *achievements* and to distinguish them from the class of *accomplishment* predicates, like "build a bookcase". One problem with providing a precise semantic characterization of the achievement class is that the tests that I have mentioned do not give consistent results, one example of this being, as we have just seen, the ability to occur in the progressive and the ability to occur with punctual time adverbs.[25] Rothstein [2004] has provided an account of progressive achievements according to which those achievements that occur in the progressive have undergone a type-shifting triggered by the progressive by which accomplishment predicates are derived from achievement predicates.[26] If this is correct, one should not assume that the beginning of the dying process described by (33), which may be the time right after Socrates drank the hemlock, coincides with the beginning of the event of Socrates' becoming dead described by (21) (since in (33) the progressive is applied to an accomplishment predicate, while "die" in (21) is an achievement predicate). Thus, the most natural option for the revised solution is to assume that accomplishment predicates and achievement predicates differ in their logical structure to the extent that, while the typical logical representation of an achievement predicate is the one we saw for "die" in (25), the typical logical representation of an accomplishment predicate is given in (36) below:

(25) die
$\lambda x \lambda i \lambda e \; \exists s \; (become(e, s, x) \; \wedge \; occur(e, i) \; \wedge \; dead(s, x) \; \wedge \; e \supset\subset s)$

(36) build
$\lambda y \lambda x \lambda i \lambda e \; \exists e' \; \exists e'' \; \exists s \; (e = e' + e'' \wedge build(e', y, x) \wedge become(e'', s, y, x) \wedge occur(e, i) \; \wedge \; built(s, y, x) \; \wedge \; e'' \supset\subset s)$

[25] See Dowty [1979] for a detailed discussion of this point.

[26] Here I am ignoring relevant literature on progressive achievements. While Moens and Steedman [1988], Rothstein [2004], and Martin [2011] agree on the view that progressive achievements involve coercing achievement predicates into derived accomplishment predicates, other authors, for example Piñón [1997] and Gyarmathy [2015], don't. Yet, as I understand it, both Piñòn and Gyarmathy agree (with what I am going to assume, namely) that the events described by achievement predicates do not include as parts the gradual processes leading to their occurrence.

Intuitively, $e' + e''$ is a complex event which has events e' and e'' as parts. In the case of building events, e' is a process of building and e" is a becoming event at the end of which the theme of the event is built. So, as it is often assumed, achievement predicates, unlike accomplishment predicates, do not have process parts. Now suppose that temporal *at* is translated as in (37) (where t is an instant):[27]

(37) at
$\lambda t\ \lambda P\ \lambda x\ \lambda i\ \lambda e\ (P(x)(i)(e)\ \wedge\ at(e,t))$

In this case, by (25) and (36) neither achievements nor accomplishment predicates could in principle combine with temporal *at*-phrases, since none of them denotes events that occur at instantaneous intervals. Notice, however, that what counts as an instantaneous interval is to some extent a context dependent matter. If we say that Socrates died at 5pm and it turns out that he died two milliseconds before 5pm, did we say something false? In ordinary contexts this kind of imprecision is tolerated and we regard (34) as true. One way to put it is that in ordinary contexts the interval that starts a few millisecond before 5pm and ends a few millisecond after 5pm counts as an instantaneous interval. Now, for achievement predicates the beginning of the interval at which the becoming event occurs may be indefinitely close to the endpoint of the interval, since the lexical semantics of these predicates does not impose any constraint on where the initial endpoint should be. For accomplishment predicates, however, this is not the case: their lexical semantics, as is made explicit in (36), requires that the beginning of the event be located at the time when the process part of the event starts. So, for accomplishment predicates one cannot locate the beginning of the interval at which events in their denotations occur at a point indefinitely close to the endpoint of the interval. This gives us a reason for the different behavior of punctual temporal adverbials with achievements and accomplishment predicates. The intervals at which events in the denotations of achievement predicates occur can be indefinitely small, thus may count as instantaneous. This is not the case for events in the denotations of accomplishment predicates.

I conclude by presenting a further objection to the revised solution based on a recent account of cessation implicatures proposed by Altshuler and Schwarzschild [2013].[28] Cessation implicatures are those implicatures that obtain when the assertion of a stative past tense sentence invites the inference that no state of the kind described holds presently. Thus, for instance, if one answers question (38-a) by asserting (38-b), the answer invites the inference that Scotty is no longer anxious:

(38) a. How is Scotty doing?

[27] I am assuming that temporal *at*-phrases are VP modifiers.

[28] The account is developed further in Altshuler [2016].

b. Scotty was anxious.

Altshuler and Schwarzschild's account is based on the following hypothesis concerning the temporal profile of states:

(39) For any tenseless stative clause φ, if φ is true at moment m, then there is a moment m' preceding m at which φ is true and there is a moment m' following m at which φ is true.

One may understand what the consequences of (39) are by assuming the instant-based interval structure which was the setting for our discussion of the moment of change. What (39) means is not that states go on forever, but that (a) time is dense, (b) states only hold at open intervals, and (c) when they hold at an interval they hold at every instant in that interval. Suppose, for example, that Scotty had a panic attack that lasted from noon to midnight. Then, according to (b)-(c) "Scotty is anxious" is true at every instant after noon and before midnight. Given (a), it's clear that for any instant t in the interval at which "Scotty is anxious" is true, there is an instant t' preceding t at which "Scotty is anxious" is true and there is an instant t'' following t at which "Scotty is anxious" is true.

Cessation implicatures may now be accounted for as follows. Let's assume that φ is a stative sentence. Given principle (39), the assumption that the time of utterance is an instant, and a standard treatment of tenses as restricted existential quantifiers over times, it follows that the proposition expressed by $\ulcorner PRES\varphi \urcorner$ entails the proposition expressed by $\ulcorner PAST\varphi \urcorner$, but not vice versa. One consequence of this is that, whenever the domain restriction on the existential quantifiers introduced by tenses does not preclude the possibility that $\ulcorner PRES\varphi \urcorner$ is true, the fact that the speaker asserts $\ulcorner PAST\varphi \urcorner$ gives rise to the quantity implicature that $\ulcorner PRES\varphi \urcorner$ is false. For example, in the case of (38), given that (38-a) makes clear that the domain of quantification of tenses is a set of instants that includes the time of utterance, the speaker's choice to assert (38-b) instead of its present tense counterpart in (40) gives rise to the quantity implicature that Scotty is no longer anxious.

(40) Scotty is anxious

Notice that, by this account, states may temporally overlap, stand in the temporal inclusion relation or have no temporal overlap, but they never abut each other. Namely, there can be no state whose last moment coincides with another state's first moment, since according to (39) there is no last moment at which a state holds and no first moment either. So, consider again the problem of the moment of change: let t_0 be an instant such that the sentence "light A is on" is true at every instant before t_0 and the sentence "light A is out" is true at every instant after t_0. What happens at t_0? Given (39), "light A is on" cannot be true at t_0, since, if it were, there would be a last

moment when the stative sentence "light A is on" is true. And "light A is out" cannot be true at t_0 either, since, if it were, there would be a first moment when the stative sentence "light A is out" is true. So, (39) requires a Kampian solution to the problem of the moment of change.[29] Principle (39), however, is incompatible with the revised Aristotelian solution, since this solution requires that there be a first moment when the light is out.

If Altshuler and Schwarzschild's account of cessation implicatures is correct, the revised Aristotelian solution is false. It is not obvious, however, that principle (39), on which their account is based, can be upheld. As we have seen, by this principle, $\ulcorner PRES\varphi \urcorner$ entails $\ulcorner PAST\varphi \urcorner$. Suppose, however, that an object a moves throughout an interval that straddles the time of utterance. Then the proposition that a is in position p does not entail the proposition that a was in position p, contrary to what (39) predicts.

Let's consider a reply to this objection. The general strategy deployed by Altshuler and Schwarzschild to question the claim that there is a first moment at which a state holds is illustrated by the following example (pp. 45-46). Suppose John was anxious for an hour and no more. At first blush, one might think that there is a first moment at which he was anxious. An alternative possibility, however, is that there is no such moment, but there is a moment t such that John is anxious at every moment *after* it. Given that there are moments after t which are indefinitely close to it, our experience of John's anxiety does not allow us to discriminate between the existence of a first moment at which John was anxious and this alternative possibility. Since one cannot exclude that this alternative obtains, from the fact that a state lasts for a limited time we cannot conclude that there is a first moment at which the state holds. Daniel Altshuler (p.c.) suggests that a similar reasoning applied to the case I described above leads one to question the conclusion that (41) fails to entail (42):

(41) Object a is in position p.

(42) Object a was in position p.

When considering the case of a's moving throughout an interval that straddles the time of utterance, one may ask: was a in p a millisecond prior to the utterance time? Was a in p one billionth of a millisecond prior to the utterance time? If it were, it would be enough to grant the entailment from (41) to (42). According to Altshuler, since one cannot exclude that a is in p prior to the utterance time even for an imperceptible time, no counterexample to (39) has been produced. This reply assumes, however, that it is impossible for an object that moves throughout an interval to be in a different position at each instant in that interval. If such a possibility exists,

[29] D. Altshuler (p. c.) points out to me that Altshuler and Schwarzschild [2013] conceive their account as Aristotelian. As I call the alternative view presented in section 7 'revised Aristotelian' a competition ensues: everyone wants to have Aristotle on their side! I won't try to resolve the dispute.

(41) does not entail (42). Since Altshuler and Schwarzschild give no reason to reject this possibility, they have not shown that the entailment holds.

Of course, if (39) is false, one question that remains open is how to account for the implicature that Scotty is no longer anxious generated by the utterance of (38-b). As Beppe Spolaore (p.c.) pointed out to me, an alternative account of the implicature is possible, which does not appeal to (39). Normally, in order to assert $\ulcorner PRES\varphi \urcorner$ appropriately, the speaker must have have obtained evidence that φ is true prior to the utterance time. Indeed, if I assert that John is happy, usually what enables me to make this assertion is that prior to the utterance time I came to know that John was happy and I have no reason to assume that his mood changed. This means that, in ordinary contexts in which $\ulcorner PRES\varphi \urcorner$ is asserted appropriately, as far as the speaker knows the time of utterance cannot be the first moment at which φ is true, i.e as far as she knows φ is true at the moment of utterance and prior to that moment. So, in ordinary contexts appropriate for asserting $\ulcorner PRES\varphi \urcorner$, the worlds compatible with the speaker's knowledge are worlds in which both $\ulcorner PRES\varphi \urcorner$ and $\ulcorner PAST\varphi \urcorner$ are true. On the other hand, ordinary contexts appropriate for asserting $\ulcorner PAST\varphi \urcorner$ may very well be contexts in which the speaker has no evidence that $\ulcorner PRES\varphi \urcorner$ is true. In this sense, in ordinary contexts, from the speaker's point of view, $\ulcorner PRES\varphi \urcorner$ is stronger than $\ulcorner PAST\varphi \urcorner$. Thus, upon hearing (38-b), the hearer may reason as follows: if the speaker had been in a position to assert (40), she should have done so, because (40) would have been the strongest statement she could make (for the goal of the conversation she is engaged in); since she has not done so and has given no indication that she is not cooperating, she is not in a position to assert (40). Since she is informed of the facts, it follows that Scotty isn't anxious now.

If this account is correct, presumably it can be generalized to cessation implicatures in matrix clauses. However, this can only be part of the story, since, in order to match the predictions of Altshuler and Schwarzschild's account, one also needs an alternative account of cessation implicatures in embedded clauses, exemplified by the dialogue in (43):

(43) a. How is the patient doing?
b. The doctor believes that Scotty was anxious.

The answer in (43-b) suggests that the doctor believes that Scotty was anxious but no longer is. Since the speaker is not implicating that Scotty is no longer anxious, but only that the doctor believes it,[30] we cannot account for the implicature by appealing to the fact that in ordinary contexts any world compatible with the speaker's knowledge in which $\ulcorner PRES\varphi \urcorner$ is true

[30]Of course, the speaker answering (43-b) to (43-a) might also implicate that Scotty is no longer anxious, besides implicating that the doctor thinks so, but the latter implicature may occur without the former, for example in case it is common knowledge that the speaker believes the doctor to be incompetent.

is also a world in which $\ulcorner PAST\varphi \urcorner$ is true, but not vice versa. I leave to further research whether the account I suggest for cessation implicatures in matrix clauses can be extended to embedded clauses and predict the whole array of data covered by Altshuler and Schwarzschild (thankfully, this is a paper on the moment of change, and not a paper on cessation implicatures).

9. Conclusions

In this paper, I discussed two solutions to the problem posed by Sextus' argument in (1). My main purpose was not to adjudicate which theory is better, but to explore their commitments and see how some objections could be answered. If I am right, the Kampian solution requires one to give up the intuition, taken for granted by much work in event semantics, according to which events of change have a culmination part in which the *telos* is reached. The revised Aristotelian solution, on the other hand, allows one to hold on to the intuition, but commits one to the existence of a first moment when the state which is the *telos* of the change is reached.[31] And this, as we saw, has empirical consequences for semantic accounts as well. So, it seems to me that, although matters may remain open, the attempt to find out what is wrong with Sextus' argument has allowed us to sharpen our understanding of issues that were kept in the background of current work in semantics. For this, I think we should be grateful to the old skeptic.

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[31] A third line of solution which I did not discuss here is suggested by the accounts proposed by Piñón [1997] and Gyarmathy [2015]. According to these authors, the event described by the sentence "Socrates died" is an instantaneous event (or an event taken as instantaneous in context, in Gyarmathy's view) occurring at a time when Socrates was dead (when the state of Socrates' being dead begins). This proposal bites the bullet by rejecting Sextus' premise C and accepting that Socrates died when he was dead.

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