

Spatio-Temporal Analogies

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An assessment of the similarities and differences between space and time has played an important part in the development of the views of a number of philosophers about time. Examples of statements about time are compared with allegedly corresponding statements about space to give us analogies and disanalogies according to whether the statements have the same or different truth values. But now what are the general principles on which such comparisons are based? In particular, according to what criteria are corresponding sentences paired off? Are there any such general criteria? And if so, do they already presuppose a substantial commitment to one or other of the points of view at issue where analogies and disanalogies are discussed?

This paper is concerned with two specific proposals for criteria of correspondence, one which is rejected and the other tentatively advanced in its place. The exchange between Richard Gale (1968, 1969) and James Garson (1969) resulted in a formulation of what I call the *interchange criterion*, the general idea of which is that correspondence is achieved by interchanging all temporal concepts for their spatial counterparts and vice versa in the original sentence. This criterion has since received some currency (e.g. Hinckfuss 1975, Schlesinger 1975, 1980, and Shorter 1981). However, I think it is unacceptable as it stands.

The point is developed in section I where it emerges, after attempting to resolve outstanding unclarities by considering how proponents of the

criterion try to apply it, that some restrictions are needed. But the criterion thus restricted is far too narrow. This is apparent from general considerations, and is illustrated in section II by reference to a well known example of Goodman's, where a general criterion of correspondence developed along somewhat different lines is put forward. It will by then be apparent, however, that the answer to the last question of the first paragraph, at least in reference to this new criterion, must be affirmative. But although the criterion can't be used as a knock-down argument against those who see space and time as more or less incommensurable and deny a far-reaching similarity, it shows how interpretations of sentences can be found which don't require us to think of time in terms of temporal becoming and suchlike, which I take to be the point of Garson's criticism of Gale.

1. The Gale-Garson Interchange Criterion

Richard Gale regards space and time as radically dissimilar and traces this view to disanalogies which hinge, so he contends, on distinctive features of temporal, as against spatial, indexicals. These distinctive features are held to support his thesis of "the objectivity of temporal becoming", of which there is no spatial counterpart, and thus to embody a fundamental source of disanalogy between space and time. His notion of temporal becoming is not first independently explained and then brought in to support the disanalogies he adduces. Rather, Gale claims to have a strategy for establishing the disanalogies, which turn, he maintains, on unique features of temporal indexicals; and temporal becoming is presented and understood in terms of these disanalogies.

The following passage shows how Gale goes about constructing disanalogies.

My next utterance of 'now' will denote a different time, even if I just wait where I am, but my next utterance of 'here' will not denote a different place unless I move about. This difference between here and present or now is due to the fact that there is no spatial analogue to temporal becoming: the present (now), unlike here, shifts inexorably,

independently of what we do. Every event later than the present will become present and every event earlier than the present did become present, to which the spatial analogue would be that every object in front (to the right, etc.) of me will occupy (become) here and every object in the rear (to the left, etc.) of me has occupied here. But whereas the former is necessarily true the latter is contingent, and what is more is almost certainly false. (1968, pp. 214-5)

Consider Gale's first example. He maintains that it is necessarily true that

(1) My next utterance of 'now' will denote a different time (from now), whereas it is only contingently true that

(2) My next utterance of 'here' will denote a spatial position different from here.

The supposition of a disanalogy here depends upon the corresponding sentences (1) and (2) having different modal status. Clearly, everything depends on the notion of a corresponding sentence, since only differences between corresponding sentences are relevant.

James Garson has proposed what seem to be two reasonable conditions governing a corresponding sentence: (i) it should be the result of replacing every temporal concept by a corresponding spatial concept, and (ii) should spatial concepts occur in the original sentence, they must be replaced by corresponding temporal concepts in the corresponding sentence. I refer to them jointly as the interchange criterion. They leave open the question of what the spatial and temporal concepts, and their counterparts, are, which has to be decided before they can be applied. The point of condition (ii) is that the sentence corresponding to the corresponding sentence is the original sentence, so that the correspondence relation is symmetric. And symmetry is surely a necessary condition on any adequate criterion.

Following Garson, we see by applying (i) to (1) that (2) is not in fact the corresponding sentence since the temporal concept 'my next utterance' has been ignored. What we should have is rather something like

- (3) The spatial position denoted by my utterance of ‘here’ which is closest to the right is different from here.

But this is necessarily true if (1) is, and so there is no disanalogy.

(The question of suppressed reference to space and time also arises in what might seem to be a better way of getting across the point of Gale’s first putative disanalogy. Instead of (1), it might be said that

- (4) Two distinct utterances of ‘now’ will denote different times

is necessarily true, whereas

- (5) Two distinct utterances of ‘here’ will denote different places

is not. But a moment’s reflection shows that this is wrong. Two utterances of ‘now’ at the same time—by different people, or one written and the other spoken by the same person—would denote the same time. And of course, two distinct utterances of ‘here’ by different people at the same time would denote different places. The tacit assumption underlying the alleged necessary truth of (4) is that the distinction between the two utterances—by which we can understand sounds or visible signs—arises from their being made at different times. But now although

- (6) Two utterances of ‘now’ at different times will denote different times is obviously necessarily true, so too is the corresponding

- (7) Two utterances of ‘here’ at different places will denote different places.)

Similarly, Garson argues that the sentence corresponding to Gale’s second example,

- (8) Every event later than the present will become present and every event earlier than the present has become present,

is not, as Gale suggests,

- (9) Every object in front of me will occupy here and every object in the rear of me has occupied here,

but rather

- (10) Every object in front of me is here there (at a spatial position in front of me), and every object behind me is here there (at a spatial position behind me).

Account has been taken here of the temporal reference implicit in the tenses of (8), and once again there turns out to be no disanalogy. Both original and corresponding sentence have the same modal status. (Actually both sentences are, I think, illicitly constructed in view of the attempt to iterate indexicals, the implications of which McTaggart has warned us. But I won't labour the point here.)

Garson's criterion is thus sufficiently clear to show that the examples produced in *The Language of Time* do not suffice to establish a disanalogy between space and time as Gale had hoped. But this has not been sufficient to deter Gale (see his 1969 paper) in the belief that spatio-temporal disanalogies supporting his thesis can be found. In the interests of generality, then, let us look again at how Garson applied his criterion to Gale's examples and consider how the criterion might be sharpened.

A source of vagueness hinted at above was the notion of spatial and temporal concepts and which are the counterparts of which. This seems to present no real problem in the case of (1). Obviously there is no temporal analogue of the three dimensionality of space, and this is not what Gale is seeking to establish. Time is compared to a single spatial dimension; 'here' is taken to be the spatial counterpart of 'now', and 'closest to the right of' is taken as the spatial counterpart of 'next'. Clearly the example doesn't suffice to show that there is a distinctive quality of temporal becoming which lacks a spatial counterpart. The discussion of the second example is somewhat more controversial. Gale takes the sentence (8), which is about events, to have a corresponding sentence about objects. Like many other authors, Richard Taylor also shifts from talking about events to talking about objects, and vice versa, in his classic (1955) paper, although he manages on the whole to see analogies where Gale sees disanalogies. It is by no means obvious, however, that such replacement is sanctioned by either of Garson's two conditions since an event is neither a specifically spatial concept nor a specifically temporal concept. Events

occur in a place at a time, and objects occupy places at times, so that it might be more appropriate to say that objects and events are spatio-temporal concepts. Gale's manner of argument would then suggest that Garson's two conditions can be supplemented with a third to the effect that spatio-temporal concepts be exchanged with their counterparts, and that events and objects are counterparts of one another. No motivation is given for exchanges of spatio-temporal concepts in *The Language of Time*, however, and we will have to consider whether any can be given. But I see no reason for interchanging objects and events.

A decision on this last point was not necessary for the purpose of dealing with Gale's second example since Garson's point stands whether we stick with events and write as the sentence corresponding to (8)

(11) Every event occurring in front of me is here at a spatial position in front of me ...

or follow Gale and go over to talking about objects as in (10). However, the examples of disanalogies put forward by Gale in his reply to Garson as an alternative defense of his thesis depend heavily upon the introduction of special notions like sortal-object and sortal-event together with an intricate discussion of what their correlates could be in corresponding sentences. It would appear that the interchange criterion provides no guidelines for dealing with such cases, and that Gale is free to find cases involving concepts to which Garson's (i) and (ii) do not apply. There is clearly a danger here. To allow the protagonist to keep the initiative in this way would be to accept that we don't have a complete criterion of correspondence and are prepared to modify it, with whatever further complexities that may entail, in the light of additional types of concept as they crop up. The antagonist's strategy would be reduced to ad hoc skirmishes, whereas it would obviously be preferable to deal with the matter in the light of explicitly stated general principles. To this end there is, it seems, something to be said for trying to restrict the interchange criterion so that all and only interchanges definitely sanctioned by Garson's (i) and (ii) be carried out.

Actually, Gale seems to be doing just this. Rather than thinking of objects as spatio-temporal concepts for the reason suggested above he maintains that "... a sortal-object is an essentially spatial concept" (1969, p. 404), which would allow condition (ii) to come into play. However, he goes on to argue that a sortal-event (an event terminating in an achievement), although a temporal concept, is not the temporal counterpart of a sortal-object. He does this on the basis of the contention "that the concepts of *here* and *now* are not involved in an analogous way in our concept of a sortal-object" (*loc. cit.*).¹ So he comes in the end to much the same view as I advocate, that objects (and presumably events) are not to be interchanged in corresponding sentences. But he might not have done so if he didn't also argue that events don't happen to be counterparts of objects. This raises the problem that not much is really gained by confining ourselves to Garson's two conditions so long as what falls within the mutually exclusive categories of spatial and temporal concepts, and what falls within related categories like that of spatio-temporal concepts to which the conditions don't apply, is open to such divergent interpretations. Now, Gale and I needn't dispute under which of these three headings objects and events are to be classified since, as we have just seen, we

¹ Gale would seem to be introducing the new idea here that analogies and disanalogies based on the comparison of sentences can be further used to support claims about which concepts are counterparts of which. Circularity threatens once results of the latter kind are used to support those of the former kind.

He also seems to entertain the possibility that spatial (temporal) concepts may not have counterparts, thereby blocking the generation of corresponding sentences in putative analogies and, so he concludes, establishing a distinctive disanalogy. It could well be maintained, however, that lack of a corresponding sentence argues equally against any disanalogy based on the original sentence, and indicates rather a divergence of views on such a scale as to preclude making any progress with his antagonist on the basis of the analogy-disanalogy strategy.

obtain our agreed result—certain details of the discussion aside²—by excluding them from all three categories. But terms referring to parts of space, and predicates predicated of just such spatial referring terms, are surely spatial concepts, as temporal referring terms and purely temporal predicates are temporal concepts. Garson's conditions will then require, among other things, that spatial and temporal referring terms be interchanged in all contexts. Spatio-temporal concepts are still with us, however, in the form of predicates true of n-tuples containing at least one temporal and one spatial referring term. And as the discussion proceeds we will see that occurrences of such predicates of the kind $\varphi(u_1, \dots, u_i, \dots, u_n)$ entailing that u_i is a time (space) in the original sentence are fatal for Garson's interchange criterion. There is also the problem, in the general case, of specifying exactly which referring terms are to be exchanged for which. But let us begin by considering Garson's second condition.

Is (ii) really relevant? As Garson points out, he makes no use himself of (ii) in transforming an original into its corresponding sentence. Perhaps there simply are no spatial concepts in any of the examples he discusses. However, bearing in mind that the central point of his argument was that temporal concepts are often not explicit, but that all of them must nevertheless be tracked down and exchanged for spatial concepts, we might well suspect that there are spatial concepts Garson has overlooked where Gale has overlooked temporal concepts. So let us look at (1) again with this in mind.

Garson's application of his condition (i) to (1) seems to have been based on an analysis in terms of something like the predicate 'utterance x occurring at time t_1 denotes time t_2 '. Sentence (3) is accordingly built up from a predicate 'utterance x occurring in place p_1 denotes place p_2 ' obtained by exchanging all occurrences of temporal concepts—time variables—for corresponding spatial concepts in the former predicate. But now if an utterance can sometimes be said to occur at a time, and sometimes said to occur in a place, it is surely reasonable to say that

² See footnote 6, for example.

utterances always occur both in a place and at a time, even if it is not always necessary to draw attention explicitly to both of these features. On this view what we have in both (1) and its corresponding sentence is something like the four-place predicate, ‘utterance x occurring in place p at time p denotes y ’. Availing ourselves of logical notation to make this more definite, let ‘ $O(x, p, t)$ ’ stand for the predicate ‘ x occurs in p at (during) t ’ and ‘ $D(x)$ ’ for the denotation function. (1) can then be expressed as the truth that

$$(12) \quad \forall t (t \text{ is later than now} \ \& \ \exists x (x \text{ is an utterance of 'now'}) \ \& \ O(x, p, t) \\ \quad \quad \quad \supset D(x) \neq \text{now}),$$

which holds for all places, p . The corresponding sentence should then express a truth like

$$(13) \quad \forall p (p \text{ is to the right of here} \ \& \ \exists x (x \text{ is an utterance of 'here'}) \ \& \\ \quad \quad \quad O(x, p, t) \supset D(x) \neq \text{here}),$$

and this holds for all times, t . Seen in this light, the inexplicit spatial reference in (1) is a universal quantification over places.

Although suppressed reference to space has been uncovered in obtaining (13) from (12), Garson’s criterion has not, however, actually been followed. Occurrences of “‘here’” and “‘now’” have been interchanged, as have those of ‘here’ and ‘now’, but that is all. In particular, there has been no interchange of the space and time variables p and t , nor did there seem any point in doing so. These are surely examples of spatial and temporal concepts, but I don’t think there can be any question of interchanging them. The result of interchanging space and time variables in ‘ x occurs in p at (during) t ’, i.e. ‘ x occurs in t at (during) p ’ is distinctly odd—either nonsense or, as some would prefer to say, always false, and some, necessarily false.

Gale is at least aware of this peculiarity to which the interchange criterion gives rise. Of many authors (e.g. Schlesinger 1975, Shorter 1981, Taylor 1955) who have discussed whether ‘An object cannot wholly occupy two places at the same time’ and ‘An object cannot wholly occupy two times at the same place’, or some such pair, constitute an analogy or a

disanalogy, Gale is the only one to react to what seems to me to be a clear symptom of non-correspondence in the second of these sentences. “Before we ask”, he says, “whether this is a conceptual truth [which would give us an analogy on his account], we must ask what would be meant by an object ‘wholly occupying a time at a space’—a most bizarre notion” (1969, p. 399). However, he seems to take this to mean that he is at liberty to “find some meaning for” the incomplete or defective expression he takes his criterion of correspondence to give him. But this is tantamount to finally construing the corresponding sentence without resort to a general criterion of correspondence, which can’t be right. The correct corresponding sentence simply can’t contain a bizarre spatio-temporal relation if the original doesn’t—this must be a condition of correspondence. The only thing to be “found” is an analysis of the original sentence and the general criterion of correspondence should do the rest; otherwise, we are back to deciding correspondence from case to case again.

A more charitable interpretation of these comments might be to construe Gale as trying to find a counterpart to the original spatio-temporal predicate which can then be predicated of the spatial and temporal referring terms taken in reverse order to give the corresponding sentence, even if it is difficult to reconcile with Garson’s criterion. This interpretation is hardly borne out by his text, however, because it is doubtful that Gale succeeds in introducing a different notion as a counterpart to occupying a place at a time. At one point he actually explains the sentence ‘An object cannot wholly occupy both now and then at the same region of space’ by saying

This is a conceptual truth, because it means that it cannot be the case that an object *occupies a given place now* and at no other time and also *occupies this place then*, i.e. at some other time. (Gale 1969, p. 406; my emphasis)

And where he talks at other points about an object occupying a time at a place, the sense of the discussion indicates that he means occupying a place at (during) a time in the ordinary sense. So it is doubtful whether any interchange is actually effected at all, even with respect to spatial and

temporal referring terms, within spatio-temporal predications in Gale's examples.

Now if spatio-temporal predicates were their own counterparts, the bizarre results of the interchange criterion would threaten to eliminate analogies involving such predicates wholesale. For interchange of spatial and temporal referring terms would then simply convert true sentences containing such predicates into sentences nonsensical or false for general reasons of meaning. (Hinckfuss's example (1975, p. 81) from Maxwell's theory, where from a given rate of change $\partial x/\partial t$ we can obtain an inverse rate of change $\partial t/\partial x$ with a different value, would seem to be an illustration of the exception rather than the rule. We will see shortly how another of his examples fares distinctly less well under the same treatment.) Alternatively, spatio-temporal 'core' predicates (preserved in the corresponding sentence) might be stipulated to be symmetric with respect to the positions of space and time variables. But now this runs dangerously close to eliminating disanalogies as impossibilities. (Interchanging *both* spatial and temporal referring terms *and* spatio-temporal predicates φ for their converses—i.e. predicates ψ such that $\psi(x, t, p)$ iff $\varphi(x, p, t)$ —would, in the absence of such a stipulation, have the same effect.) These pitfalls may go some way towards explaining why philosophers who profess to be following the interchange criterion frequently produce bizarre sentences when spatio-temporal predicates are involved. But the fact remains that it is often difficult to see how they intend the application of the criterion to be understood whilst simultaneously comprehending what the result literally means; and the most sensible interpretation of the case in question often conforms to the strategy Gale was said at the end of the previous paragraph in fact to be following, namely to effect no interchange at all. Consider, for example, a point on which Schlesinger takes issue with Hinckfuss.

Hinckfuss (*loc. cit.*) maintains that "spatial movement seems to be within our control", whereas "our movement through time seems to be inexorable". Schlesinger, on the other hand, maintains that

Spatial movement is to be understood in terms of space covered during a certain amount of time Obviously, then, for temporal movement to

be a counterpart of this, we have to speak of time being covered during a given amount of space. (Schlesinger 1980, p. 127)

But this is far from obvious. 'Cover' is a verb we use to say that an object x traverses a stretch of space, p , during an interval of time t . Let us write it $C(x, p, t)$. Schlesinger wants to say something like 'We can cover t at p ' (his choice of preposition), and as an alternative to Hinckfuss's talk of 'spatial movement' and 'movement through time' we are offered the no less mysterious 'covering of time at a space'. In attempting to apply the interchange criterion both authors have allowed themselves to slip into intractable metaphors, the arbitrariness of which is reflected by the fact that one sees in the criterion a case for disanalogy where the other sees in the same criterion a case for an analogy. It is certainly not the criterion of correspondence which carries the burden of the argument here. Schlesinger was right, I think, in beginning with a sentence explicitly based on the predicate $C(x, p, t)$ rather than talking in tendentious metaphors from the outset. But then he goes off into an unwarrantedly obscure description of the simple fact that we can often decide with what speed to cover a given distance, and which only obfuscates the fact that the corresponding sentence is in this case identical with the original. No question of interchange arises, either of predicates (Hinckfuss?) or spatial and temporal referring terms (Schlesinger). The problem with Hinckfuss's example is the failure to make explicit a suppressed spatial reference in his original sentence, a sure symptom of which is the dubious metaphors we otherwise seem to be stuck with.

A similar case where Hinckfuss and Schlesinger have diverging opinions should be dealt with, I think, along the same lines. Space, according to Hinckfuss (p. 90), is transparent to light whereas it doesn't even make sense to speak of an interval of time as transparent. But Schlesinger sees "no conceptual barrier in applying these terms ['transparent' and 'opaque'] to temporal intervals" (1980, p. 14). His strategy in this case, however, is to draw a space-time diagram which he then rotates through 90° to obtain another diagram which he thinks can be given a physical interpretation and thus yield a corresponding sentence.

This 'rotation criterion', according to which the original sentence is represented by lines drawn on a space time diagram which is then rotated through 90° and a physical interpretation of the result found which is held to give us the corresponding sentence, is a device frequently employed by proponents of the interchange criterion (cf. Hinckfuss 1975, pp. 66-9; Shorter 1981, pp. 71-5). Unfortunately it is never really discussed exactly what relation the device is supposed to bear to the interchange criterion, what restrictions, if any, the original sentence imposes on the interpretations allowed in obtaining the corresponding sentence from the rotated diagram, and even when the device should and when it shouldn't be employed. In the present case, however, it suffices to say that light's traversing a medium or space during a period of time (without dispersion), which is what transparency comes down to, is equally about temporal intervals as about stretches of space and so doesn't give us a property of space time lacks. Original and corresponding sentence are again identical.

I have argued that what plausibility there is in Garson's conditions depends on incomplete paraphrase and consequent failure to appreciate their full implications. When are interchanges allowable, then? No objection has been raised to interchanges such as those involved in the first conjuncts of the antecedents of (12) and (13), where interchange of spatial and temporal referring terms is simultaneously accompanied by an interchange of purely temporal and corresponding purely spatial predicates. The objection was to simultaneously accompanying changes of spatio-temporal predicates, of which no one seems to have made any good sense, but equally to interchanges of temporal and spatial referring terms within spatio-temporal predications without change of the predicate. Why not, then, simply restrict interchange to purely spatial and purely temporal predicates and what they are predicated of, conforming with what, on a charitable interpretation, is the actual practice of proponents of the interchange criterion? The result may be no change at all. The corresponding sentence would then be identical with the original, which is often, as the discussion of the Hinckfuss-Schlesinger disagreements illustrate, just the result we want. This won't do, however. The examples

considered so far are so simple as to constitute special cases. What is to be done where the original sentence involves several spatio-temporal predications? In general, some sort of change of spatial and temporal referring terms in spatio-temporal predications may be required. A more complex example must be considered in order to bring out the relevant features, and an often discussed example of Goodman's will serve this purpose nicely.

2. Goodman's Example

"Two things may approach and then recede from each other in space", Goodman (1951, p. 300) says, "... but ... never become nearer and then further apart in time". I disagree with Goodman that there is a disanalogy to be had here, and in so doing agree with Schlesinger's result (1980, pp. 4-5). But I don't see how the references Schlesinger makes to the graph he draws show how the case conforms either to his criterion of abstracting to common continuum features or to the interchange criterion, which are the two criteria of correspondence he wants to motivate. (For some reason he is not tempted to rotate the space time diagram in this case. It may have been some such consideration which led Goodman to his conclusion.) I will proceed by first offering as intuitively plausible a treatment of this particular case (with the result just mentioned), and then formulating the procedure involved in general terms as a criterion of correspondence. This is followed by some comments on the assumptions involved.

The original sentence contains an open sentence of the kind ' x is spatially nearer y at t_2 than at t_1 , and then further apart at t_3 than at t_2 ', the variables being bound by existential quantifiers in the original. This open sentence can be analysed as the conjunction of

(14) At t_1 , x occupies place p_1 and y place p_2 & at t_2 , x occupies place p_3 and y place p_4 & at t_3 , x occupies place p_5 and y place p_6 ,

and

(15) t_2 is between t_1 and t_3 & the spatial interval between p_3 and p_4 is less than both that between p_1 and p_2 and that between p_5 and p_6 .

Abbreviating ‘occupies’ with ‘O’, (14) is just

$$(14a) [O(x, p_1, t_1) \& O(y, p_2, t_1)] \& [O(x, p_3, t_2) \& O(y, p_4, t_2)] \\ \& [O(x, p_5, t_3) \& O(y, p_6, t_3)],$$

What is the corresponding sentence? Restricting interchange to (15), i.e. the purely temporal and the purely spatial predications, is obviously inadequate. But replacing each occurrence of t_1, \dots, t_3 by p_1, \dots, p_3 , respectively, and the original p_1, \dots, p_6 by t_1, \dots, t_6 , respectively, here and in the quantificational prefix, would involve the bizarre notions discussed towards the end of the last section. t_1, \dots, t_6 in the corresponding sentence must somehow be determined by p_1, \dots, p_3 analogous to the way p_1, \dots, p_6 were determined by t_1, \dots, t_3 in the original. What corresponding change in (14a) is required? This I’ve tried to indicate by the formulation of (14), and the square bracketing in (14a) which groups open sentences dealing with different places at the same time. The open sentence corresponding to (14a) should deal analogously with the same place at different times. The corresponding open sentence is thus the conjunction of

$$(16) [O(x, p_1, t_1) \& O(y, p_1, t_2)] \& [O(x, p_2, t_3) \& O(y, p_2, t_4)] \\ \& [O(x, p_3, t_5) \& O(y, p_3, t_6)]$$

and

$$(17) p_2 \text{ is between } p_1 \text{ and } p_3 \ \& \ \text{the temporal interval between } t_3 \text{ and } t_4 \text{ is} \\ \text{less than both that between } t_1 \text{ and } t_2 \text{ and that between } t_5 \text{ and } t_6.$$

The corresponding sentence is then formed from this open sentence by binding all the variables with existential quantifiers, and is true just in case the original sentence is.

A general procedure for converting original to corresponding sentence in line with this treatment of Goodman’s example can be formulated as follows. Assuming the original is formulated in a three-sorted first-order language with spatial and temporal variables (ranging over distances and durations as parts of space and time) and individual variables, let Q^* be Σ when Q is \exists , and Q^* be Π when Q is \forall , and work through the atomic formulas φ from left to right. If φ contains no temporal variables and p_{i_1}, \dots, p_{i_n} are all its spatial variables, rewrite them as t_{i_1}, \dots, t_{i_n} , respectively.

Then replace any occurrence of Qp_{ij} binding this occurrence of p_{ij} in φ by Q^*t_{ij} , for $1 \leq j \leq n$. Similarly if φ contains only temporal variables. If p_i and t_j both occur in φ , change p_i to p_j and t_j to t_i , and then change any occurrence of Qp_i binding this occurrence of p_i in φ to Q^*t_i , and of Qt_j binding this occurrence of t_j in φ to Q^*p_j . Finally, change all occurrences of ‘ Σ ’ to ‘ \exists ’ and of ‘ Π ’ to ‘ \forall ’.³

A number of details here need to be examined. First, no predicate letters are changed at all as the procedure stands. But although the gist of the discussion in the last section was to restrict changes of predicates, nothing quite so sweeping was envisaged nor really need be introduced here. It was assumed there that purely spatial (temporal) predicates do have corresponding purely temporal (spatial) counterparts. These might be enumerated in a list and the corresponding changes incorporated into the procedure. Champions of the incommensurability of space and time may object to every item of the list. But if like Gale their intent is to establish this thesis on the strength of disanalogies, some independent positive argument would be required for discounting what seem to be natural counterparts. Gale has not himself reacted in this way to examples like those mentioned in the previous section, but seems on the contrary to want to follow suit—cf. (8) and (9). It wouldn’t be correct to argue, then, that the sentence ‘Times are composed of instants’ *couldn’t* give rise to an analogy because replacing ‘times’ by ‘spaces’ yields the contradictory ‘Spaces are composed of instants’ (cf. Hinckfuss 1975, pp. 63-4). No analogy can be based on this particular comparison, of course, but that would hardly justify the conclusion that it is impossible to draw an analogy. The corresponding sentence is ‘Spaces are composed of points’, whether ‘is composed of’ is taken as a distinct counterpart of the corresponding predicate in the original sentence or the same predicate.

³ The special cases discussed in section I where original and corresponding sentences were said to be identical would, on this criterion, only be identical up to logically equivalent rearrangements of existential or universal quantifiers in the prefix.

Revising the procedure along these lines is, perhaps, at odds with the train of thought underlying the thesis Schlesinger develops in his 1975 article, that spatio-temporal analogies reflect common continuity features. This thesis does seem to require abstracting to common predicates, so that the example of Hinckfuss's just mentioned, for instance, might on this view be represented as 'Times contain parts which don't themselves contain parts', yielding the corresponding sentence by simply replacing 'times' with 'spaces'. The original sentence here is now one entailed by, but which doesn't entail, the original example. Surreptitious switching of examples (not unknown in this debate— cf. Schlesinger's changing of Hinckfuss's example about spatial movement) shouldn't, perhaps, be considered fair play. However, there may sometimes be a point in explicitly changing the example by weakening in the light of the general correspondence procedure. Consider (12) again, where 'later than' was changed in the corresponding sentence to 'to the right of'. Why not change it to 'to the left of' instead? There is a measure of arbitrariness in establishing counterparts here which suggests that the substantial point at issue in Gale's example could be more precisely located by changing the example. Reformulation of the original in terms of betweenness, or more conveniently in terms of the mereological predicate 'is separate from' would make it clear, at least to the satisfaction of Gale's opponent, that the direction of time (which, he grants, can be brought out by disanalogies involving causation, for example) is not the point of this particular example.

Second, it is assumed that spatio-temporal predicates contain only one temporal and one spatial variable. A modification of this implausible assumption accommodating spatio-temporal predicates with equal numbers of spatial and temporal variables is easily introduced. Whether this restriction on spatio-temporal predicates can always be insisted upon I don't know. This implies a corresponding uncertainty about how generally applicable the criterion is.

Third, returning to an earlier theme, reference to individuals, be they material objects, events, or parts in one sense or another of objects and

events, remains unchanged. As I have said, I don't see any good reason for making any such changes; and it is difficult to see that those philosophers who do advocate such changes in particular cases are being guided by a general criterion in doing so. To illustrate with just one example, Schlesinger (1980, pp. 12-3) argues that if an object such as a television set is broken into spatial components by removing, say, its entire front part, the resulting objects are very different from the original whole functioning system. However, when we divide such objects "into their component temporal parts, the resulting systems are merely shorter versions of the original whole". Schlesinger goes on to argue that this doesn't establish a disanalogy because of the existence of counterparts showing just the opposite kind of asymmetry. "A counterpart in the relevant sense to a particular such as a complex machine would be, for example, a symphony heard throughout an extended region of space and time". Chopping off the last movement would change the character of the event, whereas reducing its spatial extent would leave us with the same symphony.⁴ But now Schlesinger didn't talk of events moving as the situation corresponding to objects covering space in time in the example discussed towards the end of the last section, but rather continued to talk of objects. When is it appropriate (permissible, necessary) to introduce events as the counterparts of objects and when not on his view? Inconsistency of this sort shows that what Schlesinger has in mind cannot be a correspondence procedure of the kind outlined in this section supplemented with the directions to interchange 'is an object' with 'is an event', and 'occupies' with 'occurs'. This case might be alternatively described by (saying Schlesinger is surreptitiously) changing the original sentence to one involving existential quantification over individuals which are either objects or events, and which happens to be satisfied by the television set which is broken. No

⁴ Schlesinger's original sentence is more complicated than might at first appear, involving several concepts which have not yet been explicitly introduced, and further assumptions about some which have. See the appendix for a discussion.

interchange of references to objects and events would then be involved in obtaining the corresponding sentence, even though the corresponding sentence happens to be satisfied by an event.

Finally, the criterion as stated only allows change of variables. It could be extended to indexicals by stipulating the replacement of ‘now’ by ‘here’ and ‘then’ by ‘there’ in purely temporal predicates, and conversely for purely spatial predicates. Spatio-temporal predicates $\varphi(x, \alpha, \beta)$ would be rewritten $\varphi(x, \gamma, \delta)$, where γ is here, there or p_i according as β is now, then or t_i , with a corresponding change of quantifiers as before where appropriate, and conversely for δ and α . We must add to the list of interchangeable counterparts the predicate pair ‘is an utterance of “now”’ and ‘is an utterance of “here”’, and a similar pair for “then” and “there”. This then sets us thinking about dates and names of places. But I can’t see any substantial point in talking about counterparts here. This is a question best dealt with by not allowing it to arise, requiring that original sentences be construed in an appropriately general form.

This criterion has not been devised to capture what, in allusion to McTaggart, is sometimes called the A-theorist’s understanding of time, and could hardly be used to dissuade such a philosopher of his conviction that time is really incommensurable with space. He would probably object to the very use of time variables, and we might never reach agreement over the analysis of original sentences. But it offers a strategy for dealing with ordinary language sentences the A-theorist might offer in support of his view, showing that his interpretations are not obligatory. Garson began along this path, but stopped short of the goal. I hope at least to have brought this end more clearly into view.⁵

Appendix

Schlesinger’s example about the television set which is broken into spatial parts can be approached as follows. It no longer involves comparison of

⁵ I am grateful to George Berger, George Schlesinger and members of the Departmental seminar at Stockholm for many useful comments.

time with a single spatial dimension, and spatial variables should now be thought of as ranging over (continuous) regions considered as parts of space. Now, suppose ‘part of’ between individuals is defined by the equivalence

$$P(x, y, t) \equiv \exists p_1 \exists p_2 (O(x, p_1, t) \& O(y, p_2, t) \& p_1 \subset p_2),$$

where ‘ \subset ’ is the mereological relation ‘part of’ and ‘O’ stands for ‘occupies’. (The defining condition here is in fact only necessary; we wouldn’t ordinarily allow arbitrary parts of the spatial region occupied by an object to define parts of the object. But I don’t want to make this discussion more involved than it already is.) Two regions p_1, p_2 abut—written $A(p_1, p_2)$ —iff they are separate and there is a region overlapping both but not any other region separate from both (i.e. $p_1 | p_2 \& \exists q (Ov(q, p_1) \& Ov(q, p_2) \& \forall r (r | p_1 \& r | p_2 \supset r | q))$), where ‘|’ is mereological separation and ‘Ov’ mereological overlapping). Abutment between individuals can then be defined by the equivalence

$$A(x, y, t) \equiv \exists p_1 \exists p_2 (O(x, p_1, t) \& O(y, p_2, t) \& A(p_1, p_2)).$$

An individual x can now be said to be connected at t — $C(x, t)$ —if any two parts y, z of x are identical with the first and last members of some sequence x_1, \dots, x_n of abutting parts of x at t (i.e. $A(x_1, x_2, t), A(x_2, x_3, t)$, etc.). Connectedness at t is a necessary condition of identity at t for many individuals, perhaps all. This is particularly difficult to decide in the case of events because of the difficulty in demarcating the region occupied by an event (which I assume is the region in which it occurs). Consider a garden party, for instance; does this occupy the garden or just the mereological sum of the disparate regions occupied by individual guests? If every guest can hear the guests in his/her immediate neighbourhood, perhaps this suffices for connectedness; but then where is the boundary to be drawn? Perhaps an event occupies a region with the smallest boundary satisfying such conditions. However, Schlesinger’s original sentence concerned an object, and this can now be formulated as

$$\exists x (\text{object}(x) \& \exists t_1 \exists t_2 (t_1 | t_2 \& C(x, t_1) \& \exists y \exists z (P(y, x, t_1) \& P(z, x, t_1) \& \neg \exists w (P(y, w, t_2) \& P(z, w, t_2) \& C(w, t_2)))))).$$

The criterion gives us the following corresponding sentence

$$\exists x (\text{object}(x) \ \& \ \exists p_1 \ \exists p_2 (p_1 | p_2 \ \& \ C(x, p_1) \ \& \ \exists y \ \exists z (P(y, x, p_1) \ \& \ P(z, x, p_1) \ \& \ \neg \exists w (P(y, w, p_2) \ \& \ P(z, w, p_2) \ \& \ C(w, p_2))))),$$

where $C(x, p)$ and $P(x, y, p)$ are defined analogously (according to the correspondence criterion) to $C(x, t)$ and $P(x, y, t)$. The spatial part-of relation $P(x, y, p)$ is straightforward; it just means that x occupies the same place as y for part of the time. (For stationary objects this obviously means $x = y$, and I would say the same of events; I'll come to moving objects shortly.) Spatial abutment $A(x, y, p)$ just means that x and y occupy the same place at some abutting times. ' $C(x, p)$ ' is a longer tale, and leads me to be more definite about the interpretation of 'O'.

Whereas events are changes and don't themselves change—at any rate, they don't move (cf. Dretske 1967)—objects do move, and this makes the interpretation of $O(x, p, t)$ when x is an object more complicated. I interpret it in accordance with the principle that p is the sum total of regions, neither more nor less, covered (occupied) by x at some time during t . (The predicate $C(x, p, t)$ introduced in connection with the discussion of what Hinckfuss and Schlesinger say about covering space at the end of section I thus becomes a special case of $O(x, p, t)$.) If x is, for instance, a car driving along a road during t , p is the volume swept out along the road between the place where the rear bumper is at the beginning of t and the place where the front bumper is at the end of t . Another car driving in the same direction but further along the road and within this volume at the beginning of t would occupy a space including a proper part of p during t . But it couldn't occupy p during a part of t , even if moving in the opposite direction and beginning at the other end of p —it would have to side-step. So $P(x, y, p)$ implies $x = y$ quite generally. An individual x , object or event, *wholly* occupies a region at a time, so that $O(x, p, t)$ implies $\neg O(x, q, t)$ for all proper parts q of p , although proper parts of x may occupy proper parts of p at t . And if t_1 is a proper part of t and $O(x, p, t)$, then x could occupy some proper part of p during t_1 .

' $C(x, p)$ ' means that any two spatial parts, y, z , of x are the first and last members of some sequence of spatially abutting parts of x . The members

of this sequence are all identical with x (being spatial parts), as we have just seen, and $A(x, x, p)$ is true iff x is stationary at p during some time (assuming time is infinitely divisible, i.e. any time is divisible into abutting pairs). ‘ $C(x, p)$ ’ therefore boils down to ‘ x is stationary at p during some time’. The corresponding sentence, then, is satisfied by objects that are permanently stationary but which may occasionally wobble, though never so much as to occupy two separate regions (at different times). For such an object x occupying p_1 at some time there are objects $y, z (= x)$ occupying p_1 which are not identical with any object w occupying another (separate) place p_2 . Objects that move sufficiently to occupy non-overlapping regions falsify the sentence. Now the identification of the same place at different times would seem to require the existence of more or less stationary objects, but whether they must fulfill such strict conditions as to satisfy the corresponding sentence and give us an analogy is not so obvious.

It is interesting to consider what would be the case if we talked of events rather than objects. I interpret ‘occupy’ in accordance with Dretske’s stipulation that “it is false to locate an event at a position at which only part of the event occurs” (1967, p. 488). This extends what was said above about events wholly occupying a region at a time, for if x is, say, an all-day party at which guests wandered in both the house and the garden, t the time between lunch and tea when everybody was in the garden, p , then $O(x, p, t)$ is false. We avoid in this way the absurd result that events move, e.g. from the house to the garden.⁶ Understanding the region occupied by an event x as the region in which it occurs in this way gives us a simple interpretation of $O(x, p, t)$. The original sentence is then true because, assuming events are connected at some time (see above), all events are such that what are parts of them at one time cannot be parts of another event occurring at another time. (Whereas parts of an object at one

⁶ This is to dispute Gale’s claim, concerning his example of a basketball game the first half of which is played in p at t_1 and the second half in a different place q at t_2 , that “the game-event wholly occupies p during t_1 and wholly occupies q during t_2 .” (1969, p. 404; my notation).

time might not all be part of a single, connected object at another time, parts of an event at one time can't even be parts of an event at a different time.) However, $C(x, p)$ is always false where x is an event because $A(x, x, p)$ is always false, no event occupying anywhere at two distinct times. Thus, the corresponding sentence is false and we have a disanalogy.

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