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Published paper
Le Poidevin, R. (2004) *Space, supervenience and substantivalism,* Analysis Volume 64 (283), 191 -193.

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Space, Supervenience and Substantivalism

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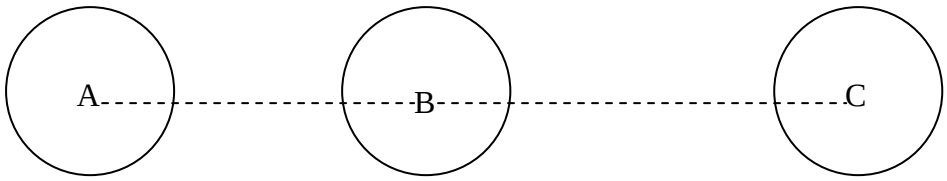
1. Why space needs supervenience

Consider a straight line on a flat surface running from point A to C and passing though B. Suppose the distance AB to be four inches, and the distance BC to be six inches. We can infer that the distance AC is ten inches. Of all geometrical inferences, this is surely one of the simplest. Of course, things are a little more complicated if the surface is not flat. If A, B and C are points on a sphere, then the shortest distance between A and C may be smaller (it may even be zero). We can make our inference immune from concerns about non-Euclidean spaces, however, by qualifying it as follows: if AB = *n*, and BC = *m*, then, in the direction A⇒B⇒C, the distance AC is *n* + *m*. This is apparently entirely trivial. But trivial truths can hide significant ontological ones. Let us translate our mathematical example to the physical world, and suppose A, B and C to be points, still in a straight line, but now at the centre of gravity of three physical objects:



As before, AB + BC = AC (for the appropriate choice of direction in space—a qualification we will simply assume from now on). But these distances now represent (we suppose) real spatial relations between the objects. And, moreover, these relations themselves exhibit a close connection.

Reasonable though that last remark may seem, it rests on an assumption that we should make explicit. It can be expressed as a natural extension of the truth-maker principle that (at least some) truths are made true by something existing in reality

(see, e.g., Simons 2000 for articulation and defence). The natural extension of this, which we will call 'the explanatory principle', goes as follows:

> *The explanatory principle*: Where *p* entails *q*, there is a corresponding connection between the truth-makers of *p* and *q* that explains the entailment.

In the case of our three objects, 'AB = 4"' and 'BC = 6"' together entail 'AC = 10"'. What, in terms of the relations that provide the truth-makers of these propositions, explains this entailment? Here is the obvious answer: the spatial distance relation between A and C *supervenes* upon the distance relations AB and BC (what appears to be the only alternative, and rather unattractive, answer is briefly canvassed in §3). The truth-makers of the first two propositions thus together constitute the truth-maker of the third.

We are still in shallow waters, it seems. But they are about to become deeper, for that natural supervenience thesis raises difficulties for both sides of the traditional dispute over the nature of space: relationism and substantivalism.

2. A problem for relationism

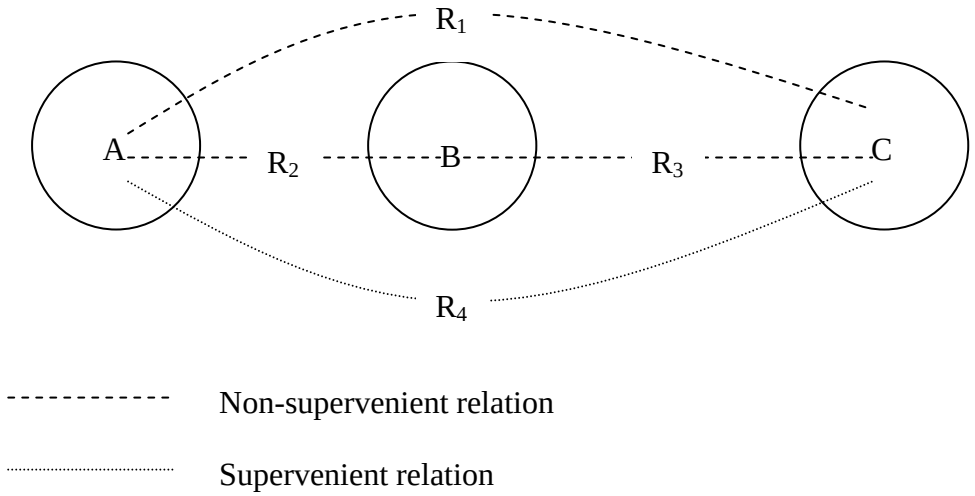
According to *substantivalism*, spatial relations between objects exist by virtue of the fact that those objects are embedded within space, whose existence and nature is independent of those objects. This existential autonomy of space gains it the title of substance (though the notion often has additional connotations: Earman 1989: 111-114). The holding of non-zero distance relations between any two objects thus entails the existence of a third object, a region of space (which may or may not be occupied), between them. As it is sometimes put, spatial relations are *mediated* by intervening points in space (Nerlich 1994: 18-20). For *relationism*, in contrast, space is not a substance. It is nothing over and above the system of spatial relations linking concrete entities. Spatial distance relations are thus direct or *unmediated*: they hold directly between objects, and are independent of any object other than their *relata* (Earman 1989: 12; Dainton 2001: 141). There is no empty space between non-contiguous objects: there is just the holding of non-zero distance relations. Against the substantivalist's insistence that unmediated spatial relations are unintelligible, the

relationist will reply that experience affords us nothing that could mediate them. Both sides of the dispute, however, agree that spatial relations are part of reality. And both sides, it seems, can make sense of the idea of alternative physical geometries. For the substantivalist, this is an issue about pathways through space. For the relationist, the geometry will be built into the relations between objects.

The kind of relationism characterised here is the non-modal form. Other versions appeal to *possibilia*. Thus, the role played by the substantivalist's unoccupied points is taken on in modal relationism by possibilities of location (Sklar 1985: 239-40). Whether or not these *possibilia* are capable of taking on the formidable role expected of them—the individuation of unoccupied points, the mediation of spatial relations, the determination of the geometrical structure of space, the relationship between incongruent counterparts—is seriously open to question (Nerlich 1994: 21-2; Butterfield (1984)). I will say no more about this version of relationism, except to remark that, insofar as *possibilia* cannot mediate spatial relations, then modal relationism faces the problem I am about to articulate. Insofar as they can, it faces the problem for substantivalism articulated in §3. The essence of the contemporary dispute between relationism and substantivalism, I shall take it, is whether or not spatial relations are mediated.

Consider, then, two objects, A and C, whose centres lie at a distance of 10" from each other. No other object intervenes between them. Call the token distance relation they stand in to each other R_1. R_1 is, according to the relationist, unmediated and independent of any object other than A and C. A third object, B, is now placed between A and C. Two new distance relations have now come into existence: R_2, linking A and B, and R_3, linking B and C. However, since R_1 is independent of any other object or relation, it continues to exist as an entirely distinct relation, linking A and C. R_1 does *not* therefore supervene upon R_2 and R_3, since it existed before those relations came into being. Now suppose, as before, distance AB to be 4"and BC to be 6". These together entail that AC = 10". The truth-makers of these propositions are, respectively, the relations (or facts about the relations) R_2, R_3 and R_1. But since, as noted above, R_1 is entirely independent of the other two relations, we lack an explanation, at the level of truth-makers, of this entailment. In order to satisfy the explanatory principle, the relationist is obliged to introduce a further relation, R_4, which is wholly supervenient upon R_2 and R_3. R_4, of course, is a distance relation

between A and C. The proposition AC = 10" now has two truth-makers, R_1 *and* R_4. But one of them—R_4—is connected in the appropriate way with the truth-makers of 'AB = 4"', and 'BC = 6"', and so the entailment is explained.



Although this overdetermination of truth is not itself an objection to the proposal (after all, the truth of 'that rainbow is coloured', just to give one example, is always overdetermined), there is something a little odd about R_1 and R_4 co-existing, yet independently of each other. It goes against the austere, frugal spirit of relationism. But it seems the relationist has no other choice. Keeping the non-supervenient R_1 and rejecting the supervenient R_4 as *de trop* means violating the explanatory principle. On the other hand, keeping the supervenient R_4 and rejecting the non-supervenient R_1 as *de trop* would undermine the relationist insistence that R_1 is entirely unmediated and independent of any object between A and C. Why, if it were so independent, would the introduction of B destroy it?

If the worst that can befall relationism is a charge of ontological profligacy, then perhaps it has little to fear. There is, however, worse to come. For now we imagine A and C moving further apart, to a distance of 12". B remains between them, on the straight line AC. Supposing the distances AB and BC both to have increased, both R_1 and R_4 undergo a transformation. We can either say that they have remained, but have been extended, or we can say that they have been replaced by two new relations, R_5 and R_6. Either way, there has been a change. And, moreover, there could not have been a change in R_1 without a corresponding change in R_4, and *vice versa*.

But why, if they are entirely independent of each other? Supposing both R_1 and R_4 to have been extended, why should they have been extended by the same amount? Supposing both to have gone out of existence, why should the annihilation of the one have been accompanied by the annihilation of the other? Supposing both to have been replaced by just one relation, a relation that is supervenient on the distance relations between A and B, and between B and C, why should the fate of R_1 (its replacement by a supervenient, rather than a non-supervenient relation) depend on the existence or non-existence of R_4? The relationist has no explanation to offer.

3. A substantivalist regress, and a conventionalist manoeuvre

Substantivalists do not face this problem, since they regard *any* distance relation between A and C as supervenient on the relations between the points of space lying between them. These are quite independent of the comings and goings of any other objects in the vicinity of A and C. The distance relation between A and C on the one hand, and those between A and B, and B and C on the other, will depend on the *same* collection of spatial points and their relations. The connection between the distances is therefore explained.

However, although this deals with one problem—that of satisfying the explanatory principle, it raises another. Our intuitive conception of space represents it as infinitely divisible. For the relationist, this means just that there is no theoretical limit as to how close two objects can be (abstracting any considerations about the forces between objects). For the substantivalist, who accepts the existence of points, infinite divisibility has consequences for the number of points there are. Infinitely divisible and substantival space is characterisable in terms of what we may call the 'density postulate', which we can state as follows:

> *The density postulate*: for any two spatial points, however close together, a straight line running from one to the other will always pass through a third point.

The consequence is not just an infinite number of spatial relations between points, on which the distance relations between objects supervene, but an *infinite regress* of

supervenience relations. The relation between any two points will supervene on relations between each of those points and an intermediate point. Those relations will then supervene on relations with further intermediate points, and so on. Since the density postulate prevents there being any end to this regress of supervenience relations, we are left with the conclusion that, for the substantivalist, there is no determinate subvenient base.

Is this a worry for substantivalism? I think it is. It precisely parallels the 'third man' objection to realism about universals: if we suppose, as the realist does, the fact that *a* and *b* share a property obtains by virtue of the fact that *a* and *b* stand in the same relation to a universal, *F*, then that fact must obtain by virtue of the further fact that *a*'s relation to *F* and *b*'s relation to *F* both stand in the same relation to another universal, *G*, and so on. At no point is the relationship adequately grounded. (See Loux 2002: 36-7 for a slightly different presentation of the difficulty, and some responses to it.) So, if we take this to be a serious worry for realism about universals, we should take the parallel problem to be a serious worry for substantivalism.

A fundamental and unspoken component of the discussion so far has been an objectivist approach to spatial metric. We have taken it for granted, that is, that there is a fact of the matter, independently of any means of measuring them, as to whether any two distances are equivalent. Conventionalists about metric deny this (Grünbaum 1970). Equivalence depends on a choice of measuring system. For some systems, the distances will be the same, for others, not. For the conventionalist, what explains the validity of our inferring distances AC from AB and BC is not the intrinsic features of spatial relations, but rather a wholly trivial feature of the measuring system. If, according to some conventionally chosen system, AB = 4 and BC = 6, then, simply as a matter of arithmetic, the system has delivered the result that AC is 10. (It is, of course, far from trivial that that same system would, if now employed to measure AC directly, deliver 10 as the result.) But conventionalism is a high price to pay, given the explanatory advantages objective metric brings (Nerlich 1994: 212-18).

So, it seems we have an uncomfortable set of choices. If we want to preserve an objectivist view of metric then, unless we allow that some spatial relations supervene on others, we cannot, at the ontological level, explain the validity of certain fundamental and unexceptionable geometrical inferences. But, once we accept this, we face a dilemma. We can choose a relationist view of space, on which supervenient and non-supervenient distance relations sit side by side, whose behaviour, though

independent, is precisely and mysteriously coincident. Or we can choose a substantivalist view of space, and a consequent infinite regress of supervenience relations, which leaves the existence of distance relations ultimately ungrounded. This array of uncongenial choices we will call ‘the Problem’.

4. The Problem in other contexts: time and non-Newtonian spacetimes

Consider again the difficulty for spatial relationism raised in §2. Does relationism about time face a similar difficulty? It does if it introduces unmediated temporal distance relations, but perhaps there is no pressure to do so. The disanalogies between time and space may make different relationist treatments of them appropriate. For Newton-Smith, relationism (of the non-modal variety) is committed to denying the possibility of temporal vacua—periods of time without change (Newton-Smith 1980: 14). The issue between substantivalists and relationists about time, thus construed, therefore centres on the possibility of such vacua. Now, if a non-zero interval between any two events is always filled by other events, then their temporal distance relation will supervene on the intervening relations, and there is no need to posit unmediated temporal relations. Or at least, there is no need if the temporal equivalent of the density postulate holds: that between any two moments there is always a third. But this postulate will then give rise to a regress precisely analogous to that faced by spatial substantivalists (§3).

Conversely, temporal relationists can remove themselves altogether from the debate over temporal vacua by introducing unmediated relations, and allowing that events can be separated by a non-zero interval, even in the absence of intervening events. (There is a strategic reason why temporal relationists may be unwilling to follow this path, namely that independent arguments against the possibility of temporal vacua would raise difficulties for substantivalism.) Of course, once they allow this, they would face the problem of accounting for the connection between supervenient and non-supervenient temporal relations—the counterpart of the difficulty in §2. We could not express it in precisely analogous terms, for what we were asking, in that earlier discussion, is what would happen to the various distance relations when we first introduced an intermediate object between A and C and then

moved A and C further apart. It would of course make no sense to talk of moving an *event* so that it occurred temporally between two other events, and then moving those events further apart in time. But we can, instead of thinking in terms of movement over time, compare possible worlds. In w_1, two events, *e* and *f*, are separated by an interval, but no event occurs in that interval; in w_2, there is the same interval between the events, but now there is an intervening event; and in w_3 the same three events are separated by greater intervals. We can now ask questions about the various supervenient and non-supervenient temporal relations in these worlds, and their connections, in a way that precisely matches the questions we asked in the spatial case. For instance, in w_2, are there two temporal distance relations between *e* and *f*, one supervenient, the other not? If so, and they are independent of each other, why do they correspond to the *same* distance? Do these relations exist in w_3? If not, what are they replaced by? By just one relation? Why? And so on. As before, we have to posit connections for which there is no explanation.

Does the Problem only arise for Newtonian space and time? By no means. Suppose spacetime to be 'neo-Newtonian': that is, although there is an absolute ordering of events in time, and objective spatial relations between points at a time, there are no trans-temporal distance relations (Dainton 2001: 184). Still the Problem remains (or a spacetime counterpart of it), since neither the spatial nor the temporal version of it depends on trans-temporal spatial relations (*vide* the remark about possible worlds in the previous paragraph).

Suppose now that spacetime is relativistic: spatial and temporal intervals between events are relative to an inertial frame. Again, the Problem remains, although it should now be expressed in terms of frame-invariant spacetime relations.

5. An atomistic solution

Conventionalism over metric, a gaping explanatory lacuna, or a vicious infinite regress. Is the choice really as stark as this? Perhaps not quite. A radical way out for the substantivalist suggests itself: reject the density postulate. That is, give up the intuitive view of space (and time) as infinitely divisible in favour of a *discrete* ontology. In discrete space, each point has a unique neighbouring point in any given direction. In explaining spatial distance relations we can say one of two things: (a)

each point, though indivisible, has a non-zero extension, and spatial distance relations between points are simply a result of the number of intervening points (considered in Grünbaum 1970: §3); or (b) spatial distance relations between neighbouring points are unmediated. Distance relations between non-neighbouring points would then supervene on those more basic relations. Whichever of (a) or (b) we choose, since both posit a fundamental subvenient base, either would halt the regress.

Neither of these proposals is unproblematic. What account could (a) give of the size of what we might call 'space atoms'? Ordinarily, we would think of an object's size as a relational, though intrinsic, property: that is, as arising from relations amongst the object's parts. But a space atom, being indivisible, has no parts. Size, as attached to the atom, would therefore have to be non-relational. But as a property of larger objects or regions of space, it would be relational. It is not clear that we can make sense of this suggestion. As for (b), by allowing the existence of unmediated spatial relations, the substantivalist somewhat weakens the case against relationism. Certainly, it would no longer be possible to complain that unmediated spatial relations are simply unintelligible.

My recommendation is that the substantivalist opt for (b). If the explanatory principle is to be satisfied and regress avoided, the substantivalist should countenance both mediated *and* unmediated spatial relations. The dispute with the relationist will then be over the existence of spatial points, rather than over the possibility of unmediated spatial relations.

The atomistic picture of space that has emerged from this discussion is one some will find repugnant both to the intellect and to the imagination, but it does sit well with a thoroughgoing metaphysical finitism.

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References

Butterfield, J. 1984. Relationism and Possible Worlds. *British Journal for the Philosophy of Science* 35: 101-116.

Dainton, B. 2001. *Time and Space*. Chesham: Acumen.

Earman, J. 1989. *World Enough and Space-Time: Absolute versus Relational Theories of Space and Time*. Cambridge, Mass.: MIT Press.

Grünbaum, A. 1970. Space, Time and Falsifiability. *Philosophy of Science* 37: 469-588.

Loux, M. J. 2002. *Metaphysics: A Contemporary Introduction*. London: Routledge.

Nerlich, G. 1994. *The Shape of Space*, 2nd edition. Cambridge: Cambridge University Press.

Newton-Smith, W.H. 1980. *The Structure of Time*. London: Routledge and Kegan Paul.

Simons, P. 2000. Truth-Maker Optimalism. *Logique & Analyse* 169-170: 17-41.

Sklar, L. 1985. *Philosophy and Spacetime Physics*. Berkeley: University of California Press.