Pegs, Boards, and Relativistic Perdurance

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Abstract

In an earlier work I developed an argument favoring one view of persistence (viz., perdurance) over its rivals, based on considerations of the relativity of three-dimensional spatial *shapes* of physical objects in Minkowski spacetime. The argument has since come under criticism (in the works of Theodore Sider, Kristie Miller, Ian Gibson, Oliver Pooley, and Thomas Sattig). Two related topics, explanatory virtues and explanatory relevance, are central to these critical discussions. In this paper I deal with these topics directly and respond to my critics by offering a new perspective on the issue.

1. Introduction

Suppose you observe a collection of two-dimensional (2D) shapes:

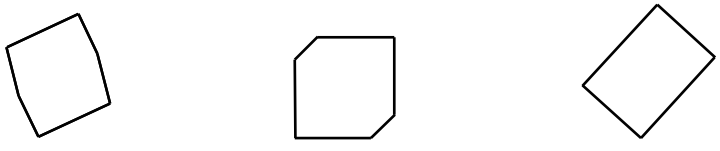

Figure 1

Are they related? Not obviously, until you realize that these shapes are *perspectival representations* of a single object, a three-dimensional (3D) cube, whose three-dimensional shape is *invariant*.

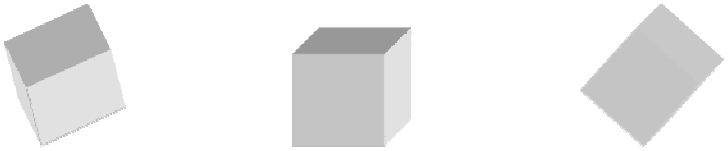

Figure 2

The phenomenon of perspectivalism is familiar. It turns on an important connection between invariance and objectivity. Any object can present itself differently in different perspectives. But there is something permanent (hence, objective) standing behind all such perspectival representations; in this case, a three-dimensional cube.

Just as there are perspectives in space, there are perspectives in spacetime. Suppose you observe a collection of *three*-dimensional (3D) shapes:

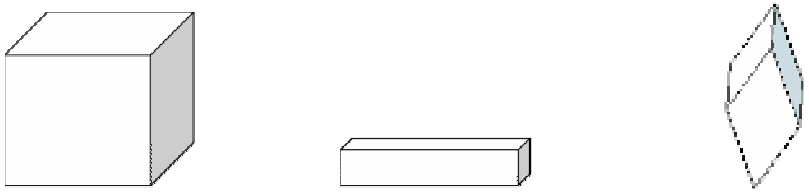

Figure 3

Are they related? Not obviously, until you realize that these shapes are perspectival representations of a single object whose shape is invariant. But what *sort* of thing must the object be, in order to present itself in such different ways in various perspectives,

without being different from itself? The answer is easily anticipated: the object must be *four*-dimensional (4D); it must be extended in time as well as space. It will then have different 3D shapes in different perspectives (associated with different inertial reference frames and related by Lorentz transformations), because such shapes will be intrinsic properties of its 3D parts. What "stands behind," and thus explains, the whole variety of 3D shapes is a single 4D entity. (I make no attempt to depict it.)

This explanation is open to the perdurantist, who believes in 4D objects, but not to the endurantist, who denies their existence. Indeed, the endurantist will have a hard time explaining how "separate and loose" 3D shapes come together in a remarkable unity, by lending themselves to an arrangement in a compact and smooth 4D volume. Where the four-dimensionalist has a ready and natural explanation of this fact: different 3D shapes are cross-sections of a single 4D object, the three-dimensionalist must regard it as a mystery. One should not expect to be able to fit an arbitrary collection of 3D shapes into a neat 4D shape, without corrugations, dents and gaps.[1]

The above argument from special relativity to perdurantism was developed in Balashov (1999).[2] The argument has since come under criticism.[3] In this paper I revisit the original argument and respond to my critics.[4]

2. The Causal Objection

The moral of the spatial analogy was this: to provide a unified explanation of a variety of 2D shapes one has to upgrade the number of dimensions possessed by objects to three. Once this is done, the 2D states of affairs are easily recognized for what they are – mere perspectival representations of the underlying 3D reality. The same sort of consideration

drives the relativistic argument. To provide a unified explanation of a variety of 3D shapes the number of the object's dimensions must be upgraded to four, whereby the 3D states of affairs can be recognized as mere perspectival representations of an underlying 4D reality. The difference, however, is that the dimension added in the second case is that of time. But the latter is widely regarded as a dimension of *causation*, and this raises the question of whether, instead of attributing the fourth dimension to objects, one could not simply point out that various 3D shapes of enduring objects result from the objects' causal evolution in time, in accordance with the laws of nature. In other words, what unifies the shapes is not the existence of a 4D entity, which is sliced up in different spacelike directions, but an underlying three-dimensional dynamics governed by the familiar physical principles. Taking this into consideration would enable the endurantist to match the explanatory achievements of the perdurantist. Kristie Miller notes:[5]

> [I]f all we had were relativistic three-dimensional shapes and no theory about how they "fit together," we would be surprised to discover that they fill the volumes that they do. The theory of special relativity, however, along with various other laws of nature, allows us to predict how objects that exist in the present, will exist in the future. That is, they allow us to predict what the four-dimensional volume of an object will be. (Miller 2005, p. 368)

But in this form, the causal objection misfires. The sequence of shapes represented in Figure 3 is *not* a causal sequence. It was not intended to describe an evolutionary process whose earlier stages determine, in accordance with the laws of nature, its later stages, in a

particular *single* frame of reference. Rather, the configurations depicted in Figure 3 represent 3D shapes of the object at different moments of time in *different* frames of reference. Speaking geometrically, they feature the shapes of various spacelike cross-sections of the worldtube of the object, which are drawn randomly at different "angles" in spacetime. For all we know, some such configurations may correspond to *crisscrossing* hyperplanes of simultaneity, whose *overall* contents, arguably, cannot be causally related.

Figure 4 gives an idea. Consider two crisscrossing spacelike "slices" R_1 and R_2 through a region of spacetime R. Suppose R_1 and R_2 are occupied by enduring objects o_1 and o_2 respectively and, to avoid begging any questions, leave it open whether $o_1=o_2$. One can argue (see Gilmore 2006, pp. 214ff) that the *overall* contents of R_1 and R_2 cannot be related as cause and effect, for, intuitively, a sufficiently large portion of the contents of R_2 (viz., R_2^f) is to the future of a sufficiently large portion of the contents of R_1 (R_1^p), whereas another sufficiently large portion of the contents of R_2 (R_2^p) is to the past of the corresponding sufficiently large portion of the contents of R_1 (R_1^f). Consequently, the total content of R_1 cannot stand in a causal relation to the total content of R_2.

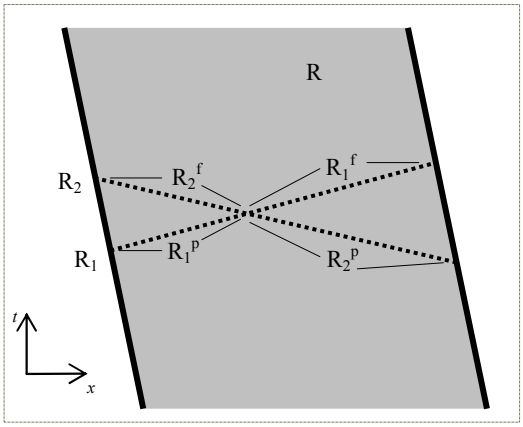

Figure 4

This does not prevent the endurantist from telling a plausible causal story about the relation among the 3D shapes. But the story must be more involved. It must include a *mereological* component, along with the causal one. It is clear that, even though the overall contents of R_1 and R_2 (Figure 4) are not related as cause and effect, their *piecemeal* contents are. In general, a collection of 3D regions of Minkowski spacetime (such as R_1 and R_2, or the regions represented in Figure 3) may be multiply occupied by a single enduring object, whose pointlike parts may have causally cemented individual careers. This suggests a better strategy for restoring explanatory parity with perdurantism.

3. The Micro-Reductive Objection

Theodore Sider notes, on behalf of the endurantist:[6]

> To have a shape at a time is just to have *parts* that are spatially related in a certain way at that time. … [R]elative to a chosen reference frame we can account for spatial relations between fundamental particles at times. Provided the three-dimensionalist can make sense of the part-whole relation in a relativistic context, then, she can account for the shapes of macroscopic objects in various reference frames. All of the perspective-indexed shapes are the result of a single set of facts about the enduring object, which include (1) the holding of the part-whole relations, and (2) the holding of the occupation relation between fundamental

> particles and points of spacetime. This also explains why the shapes fit into the 4D volume that they do. The volume is generated as the sum of all the points occupied by the parts of the object; the shapes are slices of this volume. (Sider 2001, p. 83)

The idea is this. Starting with the physical facts about multilocation of fundamental enduring particles at spacetime points, the endurantist could put her finger on the worldlines of such particles, to find out what spacetime points are occupied by what particle. She could note, next, that a given 3D object at a given time in a given reference frame is composed of a definite collection of fundamental particles. Finally, she could use this information to assemble together the genidentity lines of the fundamental constituents of a particular 3D object in spacetime. Such lines would fill a nice 4D volume, thereby resolving the "puzzle" about 3D shapes.

In Balashov (1999), I argued that while Sider's account provides the necessary elements of *some* explanation of the relation among the different 3D shapes that a single enduring object exhibits in different reference frames, such a "micro-reductive" account is explanatorily *deficient*.[7] The perdurantist has a much *better* explanation. The reason is that a good explanation must be *ampliative*: it must enhance understanding of a range of facts by invoking a *different* type of fact that would *unify* the former in a *relevant* way. No explanatory gain is achieved by merely restating the explanandum. But the latter is precisely what the endurantist "micro-reductive" strategy boils down to. Why does an enduring object, which exactly occupies a regular cubical region of space R$^{\blacksquare}$ at a certain time in a certain reference frame, also occupy a "skewed" region of space R$^{\blacklozenge}$ at some

time in another frame (Figure 3)? Sider's answer essentially is: because the object's particles have moved, in their different ways, from $R^{\blacksquare}$ to $R^{\blacklozenge}$ or vice versa. While this is certainly correct, it is not particularly enlightening. Contrast it with the perdurantist's account: $R^{\blacksquare}$, $R^{\blacklozenge}$ and many other peculiarly-shaped 3D regions are related because they are carved out from a compact 4D spacetime region $R^{\square}$ occupied by a *single* object. The difference is quite similar to the difference between "explaining" various natural phenomena (e.g., chemical explosions, superconductivity, the increase of entropy in the universe) by "grounding" them in the totality of micro-physical facts on which they obviously supervene (e.g., the facts about the location of each of the micro-particles at every moment of time in an appropriate frame) and explaining them by invoking various mechanisms (certain types of chemical reaction, Cooper pair formation, "course graining") that unify phenomena and enhance their understanding.

The issue, in short, is not about proper *grounding*: we can agree that the facts about the occupation of spacetime points by fundamental particles, along with the facts about composition at-a-time in-a-frame, ground the facts about 3D shapes.[8] The issue is rather about *explanatory relevance* and *explanatory strength*. These features are crucial because the original argument is, in essence, an inference to the best explanation.

This point cannot be overemphasized. In the next section I put the point in yet a different perspective.

4. Pegs, Boards, and Shapes

In a number of related works Hilary Putnam discusses the shortcomings of micro-reductive explanations of various macrophenomena (including, eventually, mental life) by using the following example, which, I think, bears close resemblance to the issue of relativistic shapes:

> Suppose we have a very simple physical system—a board in which there are two holes, a circle one inch in diameter and a square one inch high, and a cubical peg one-sixteenth of an inch less than one inch high. We have the following very simple fact to explain: *the peg passes through the square hole, and it does not pass through the round hole*. (Putnam 1975, p. 295)

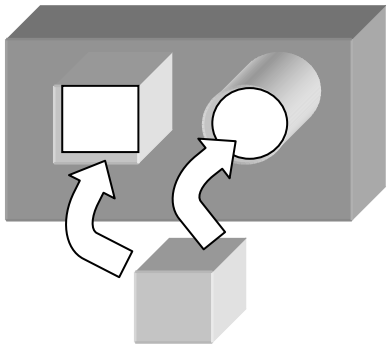

Figure 5.

One could offer two different explanations of the fact. The first would include the physical details of the microstructure of the board and the pegs, along with the laws of particle dynamics, which would show that, among all the possible trajectories of a complex physical system constituting the peg, there are some that would allow it to pass

through another complex physical system constituting the section of the board with the square hole, but there are no such possible trajectories involving the section of the board with the round hole. The other explanation would simply cite the above noted geometrical properties of the objects.

Putnam argues that the "micro-reductive" explanation is vastly inferior and that everyone can see it. The superiority of the "macroscopic" explanation is based on the fact that it brings out the relevant structural features of the situation (i.e., the geometrical shapes of the peg and the holes) and abstracts from its irrelevant features (i.e., the inscrutable amount of physical detail and the complexity of the physical laws involved), thereby achieving genuine and unified understanding of the situation (see Putnam, ibid., p. 296). There are, after all, other peg and board systems that have appropriately fitting shapes, but very few, if any, that have the same atomic composition. What needs explaining is not an unmanageable multitude of highly complex physical configurations and the resulting trajectories, but a quite manageable multitude of macro-facts about certain fitting and non-fitting pairs of shapes. And all such facts are explained by invoking simple geometrical relations (plus the notion of rigidity).

I submit that the case of relativistic shapes is relevantly similar. The perdurantist has no need to invoke irrelevant microphysical facts about the occupation of spacetime points by the fundamental constituents of material objects. And she has no need to invoke the details of local dynamics (which may, after all, be different for different kinds of objects, vary from material to material, etc.). What she is required to explain is not a multitude of disparate facts about the arrangeability of certain collections of 3D shapes in neat 4D volumes, but rather a general fact that some such collections all have the relevant

"dispositional" property. And this general fact is explained by making an equally general point that such collections are cross sections of compact 4D volumes occupied by real 4D material objects.

5. Perduring Objects Exist

But what, exactly, is involved in saying that 4D material objects are *real*? Gibson and Pooley note:

> We agree that if objects perdure then the three-dimensional shapes are cross-sections through those four-dimensional objects. The question, though, is whether Balashov is entitled to simply *assume* the existence and shape of four-dimensional objects, only for this to then ground facts about the three-dimensional parts. Balashov thinks this is right and proper, claiming that "such parts are 'carved out' from a pre-existing ontological entity…" [2000, 333]. Yet there is no obvious sense in which the four-dimensional entity "pre-exists." (Gibson and Pooley 2006, p. 191)

I concede that 'pre-existing' may be misleading in this context. There is no obvious sense in which a 4D perduring object *pre*-exists relative to its 3D parts. Perhaps 'exists' would be a better way of putting the idea. But note that it would have the same effect. The fact of existence of 4D objects, posited by the perdurantist ontology, should not be taken lightly. After all, this is precisely what the endurantist so vehemently denies! Indeed the claim that temporally-extended perduring wholes exist must be taken as

seriously as the claim that spatially extended three-dimensional objects exist. It is only if the latter exist that their 3D invariant shapes (Figure 2) can be invoked to explain a variety of 2D perspectival projections (Figure 1). No 3D objects – no 3D shapes, hence no 2D projections thereof. For the same reason, the unified and insightful explanation of a variety of 3D shapes (Figure 3), which drives the argument from special relativity to perdurantism, is available only to someone who takes 4D objects as seriously as non-philosophers take cats, trees, and (perhaps) houses.[9]

References

Balashov, Y. (1999). "Relativistic Objects," *Noûs* 33, pp. 644–662.

Balashov, Y. (2000). "Persistence and Space-Time: Philosophical Lessons of the Pole and Barn," *The Monist* 83, pp. 321–340.

Gibson, I. and Pooley, O. (2006). "Relativistic Persistence," in J. Hawthorne (ed.), *Philosophical Perspectives: Metaphysics*. Oxford: Blackwell, pp. 157–198.

Gilmore, C. (2006). "Where in the Relativistic World Are We?" in J. Hawthorne (ed.), *Philosophical Perspectives: Metaphysics*. Oxford: Blackwell, pp. 199–236.

Miller, K. (2004). "Enduring Special Relativity," *Southern Journal of Philosophy* 42, pp. 349–70.

Putnam, H. (1975). "Philosophy and our Mental Life," in H. Putnam, *Mind, Language, and Reality*. Cambridge: Cambridge University Press, pp. 291–303.

Quine, W. V. (1960). *Word and Object*. Cambridge, MA: The MIT Press.

Quine, W. V. (1987). "Space-Time," in W.V. Quine, *Quiddities*. Cambridge, MA: Harvard University Press, pp. 196–199.

Sattig, T. (2006). *The Language and Reality of Time*. Oxford: Clarendon Press.

Sider, Theodore (2001): *Four-Dimensionalism*. Oxford: Clarendon Press.

Smart, J. J. C. (1972): "Space-Time and Individuals," in R. Rudner and I. Scheffler (eds.), *Logic and Art: Essays in Honor of Nelson Goodman*. New York: Macmillan, pp. 3–20.

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Notes

[1] This can be seen easily from a spatial analogy. Replace one of the hexagons in Figure 1 with a heptagon and *then* try to fit the resulting 2D shapes into a neat 3D volume.

[2] The argument's pedigree goes back to Quine (1960, pp. 172, 253ff; 1987) and Smart (1972) who have sketched highly suggestive and heuristically valuable comments in a similar context, which, however, came short of constituting persuasive arguments.

[3] See Sider (2001, pp. 79–87), Miller (2004, pp. 66–68), Gibson and Pooley (2006, pp. 187–191), and Sattig (2006, pp. 182–183).

[4] I hasten to acknowledge that a portion of the criticism is well deserved: the way in which I put some points in Balashov (1999) (and in a related publication, Balashov (2000)) was unfortunate and misleading. The critics' reaction to those points was generally charitable; accordingly, their objections focus on more important issues – those considered below. Two related topics, explanatory virtues and explanatory relevance, loom especially large. I am indebted to my critics for pressing them.

[5] The causal issue was first raised in the present context by Hud Hudson; see Balashov (1999, p. 660n3).

[6] As far as I can see, Thomas Sattig's critical comments are similar in spirit. See Sattig (2006, pp. 182–183).

[7] At that time I was aware of Sider's then-unpublished objection (which later appeared in Sider 2001, pp. 79–87).

[8] Ian Gibson and Oliver Pooley note rightly that this grounding does not go far enough and conclude that, for this reason, Sider's objection is incomplete. One should

ask *why* a certain collection of spacetime points is occupied by a single fundamental particle. The answer, of course, comes from physics: "The various local fields around a particle determine where it 'next' is: such fields again determine where it is 'after' that; and so on until we have a complete worldline" (Gibson and Pooley 2006, p. 290). I fully agree that Sider's "micro-reductive explanation" can be further grounded in this way. And I do not see why Sider should not accept this as a friendly amendment. My point, however, remains: even with this additional grounding, the "micro-reductive explanation" is deficient. More on this below.

[9] Versions of this paper were presented at the 5th Conference of the Spanish Society for Analytic Philosophy (Barcelona, Spain, September 2007), the Pacific Division Meetings of the American Philosophical Association (Pasadena, CA, March 2008), and departmental colloquia at Idaho State University (April 2007), University of Utrecht (September 2007), and University of South Carolina (February 2008). My thanks to these audiences for stimulating discussions and to Bana Bashour for her commentary. Work on this paper was supported by a senior faculty grant from the University of Georgia Research Foundation.