

## Surfaces, holes, shadows

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## ***Minor entities: surfaces, holes and shadows***

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Some entities have traditionally been considered major, relative to other, minor entities. Arguably, material objects are core or major ingredients of the content of our pre-reflective thought about the world; objects themselves, or other entities, such as subatomic particles or spatiotemporal worms, are core elements of reflective ontologies, here taken to include scientific ontologies. Still other entities are not so central. But the major/minor division is, of course, a disputable issue. That some entities are metaphysically deemed minor can be traced back to a matter of historical or psychological accident, given that entities such as material bodies and events, say, are labeled ‘major’ purely because of their conceptual centrality, reflecting perhaps biological significance, or intrinsic complexity and interest. Some other criteria for minority may be invoked: surfaces, for instance, are lower dimensional entities, relative to material bodies; holes are characterized by their immateriality. Here we choose to stay with tradition and consider as minor some entities that are typically considered parasitic upon material bodies; from this viewpoint, key examples are surfaces, holes, and shadows; other examples include waves and knots; from slightly different points of view, events and regions of space may as well be counted in.

Issues about the existence and the nature of these items can be quite general and concern entities other than minor ones. Thus, surfaces, holes and shadows are generally considered to be *dependent* entities. General issues about dependency (conceptual, metaphysical, semantic) are not specific to them, and, besides, dependency also applies to major entities (thus a material object is said to depend on its parts) and is thus not in itself a mark of the minor. Some metaphysical issues are however more idiosyncratic to our subject-matter. What turns out to be interesting is the variety of ways in which these items turn out to depend upon other entities.

Minor entities are also interesting because their concepts can be usefully taken to constitute limit cases of certain key concepts. Holes, for instance, can be seen as degenerate bodies, i.e., as bodies deprived of

material constitution. Surfaces are again, but on a different count, degenerate bodies – bodies with one spatial dimension stripped out. Studying holes and surfaces, under this view, is to indirectly study material bodies, their core sisters.

We shall consider three kinds of minor entities – surfaces, holes and shadows – as we take them as representative of classes of conceptual tensions and metaphysical complexities (although by no means the exclusive foci of these tensions and complexities). Surfaces are paradigmatic of a tension between concreteness and abstractness; holes of a tension between space and objects; and shadows add a dynamic side to these both.

## Surfaces

Surfaces exemplify a tension between the abstract and the concrete (Stroll 1988). They are intrinsically spatial entities as they mark the limits of a material object. At the same time the notion of a surface goes beyond a pure geometrical characterization, as it is also importantly *causal*, precisely because surfaces mark the outermost limits of objects. Surfaces are where action is first exerted on an object, and where the object first reacts. As a special case perceptual contact with an object is first and foremost perceptual contact with its surface: We see bodies, in the norm, by seeing their surfaces.

Setting aside complaints to the effect that the notion of a surface referred to in philosophical discussion is artificially made to lean towards the geometrical notion (aptly voiced in Austin's (1962:100) phrase, "Where and what exactly is the surface of a cat?", intimating that the standards of precision that apply to the geometrical notion may simply not find application in the realm of ordinary objects), puzzles about surfaces arise from unresolved compromises between the abstract (spatial) aspect of the notion and the concrete (causal/material) aspect. On the one hand, if we touch or see a gold sphere (Galton 2007), we do indeed touch or see its surface, *and* we touch or see gold. Hence, one can conclude, both the sphere and its surface are made of gold. But if surfaces are to be two-dimensional entities, then no definite quantity of gold, no matter how small, can qualify for constituting a surface. The surface must be made of gold, but cannot. At this point we may try to force a solution within a scientific world view and assume that the surface is – say – the outermost atom-thin layer of an object: only to end up with a one-atom thick *film*, which then possesses *two* surfaces. If, on the other hand, one rather considers surfaces as abstract, lower-dimensional limits of objects, then one deprives them of the specific causal role they have; not being constituted of matter, they cannot be the element that supports the interaction with the world outside the object.

Another variation on the abstract/concrete theme concerns *contact* between bodies (Varzi 2007.) A cube is superposed to a second cube; they

touch, that is, the relevant surfaces are in contact. Surfaces are key explanatory ingredients of contact but the notion of a surface and the notion of contact are not obviously well aligned, as testified by the divergent accounts of their interrelation (a problem that affects boundaries of various type), when it comes to the dense structure of space, i.e., the property such that between any two points of space it is always possible to interpolate a third, distinct point. Consider our two abutting objects: how can they touch each other, if (a) the objects are topologically closed, that is, they have a boundary that is located at a definite point, and (b) between the points corresponding to the respective boundaries it is always possible to find countless many points? The worry about contact can be considered an artifact of a substantivalist conception of space, according to which space is a mind-independent, non material yet physical entity, irreducible to relations between objects in it. If space is entity-like, arguably all its parts, included points, are real, and the contact worry ensues.

Dramatic revisions of commonsense have been provided to address the worry. Bolzano (1851) dissolved the problem by claiming that one of the two bodies in contact possesses a surface and the other doesn't, a solution in line with a point-set topological account; in order to somewhat save ordinary intuitions it can be stated that it is just epistemically beyond reach which of the two bodies is surfaceless. Leonardo's view (1938:75-76) was that there is one single surface dividing the two bodies, which belongs to neither of them. (It could also be claimed that that very one surface belongs to both, something that is allegedly made possible by the dimensionless nature of surfaces.) Finally, Brentano (1976) suggested that there are indeed two surfaces, one for each object, taking up no space, but spatially coincident (think of water as the surface of air, and air as seen from under water as the surface of water).

All these accounts appear quite revisionary, and this indicates the deep instability of intuitions about surfaces.

## Holes

Both holes and surfaces are less abstract than numbers and less ephemeral than thoughts and dreams; but whereas surfaces cause concern because of their lower-dimensionality, holes are on this score more regular, as they have full three-dimensionality. Their puzzling features come from their being a type of privation.

Holes are *prima facie* conceptualized as *negative* entities, as they appear to be absences, or privations inflicted to an object. Much as this implicitly acknowledges the process behind many instances of hole formation, it does not contribute usefully to the discussion as it is not in itself transparent what absences amount to (and not all privations in this sense are holes, as we do not think of a hole in place of the missing hand of a vandalized statue: holes invoke a specific geometry).

Still the metaphor of privations can be usefully employed for characterizing some aspects of holes. Absences are typically *local*: Jimmy is earmarked as absent as he did not go to class, but the President of the US is not so earmarked, although he did not go to class either, as he was not supposed to be there. If holes are absences or privations, they are indeed local privations of matter; a certain portion of matter was expected to be where the hole is. An arbitrarily chosen region of empty sidereal space does not count as an absence in this sense; hence it does not count as a hole. Holes are thus intimately tied to objects. At a minimum, holes are existentially dependent on the objects they are in. *Prima facie*, it looks as if *this* hole could not have been in *that* object.

The tie to objects could be taken to be so strong that holes are identified not with the empty regions of space they seem to create, but with material parts of the object itself – with what Lewis and Lewis (1970) called ‘hole-linings’, the portions of the object that surround the hole. As there is a hole for each hole lining, and there is a lining for each hole, the temptation may arise to identify holes with hole linings, revisionary as the account may be. This would indeed amount to a materialist theory of holes, one that incidentally would dispel the worry with both absences and abstractions. Objections to this view include the fact that countless hole linings line one and the same hole, and that some geometric and functional properties of holes cannot easily be rewritten as properties of hole linings. The revision may well be metaphysically clean, but proves operationally impractical. At least as impractical as the hole-eliminativism recommended by Jackson

(1977), according to which although holes are not to be identified with hole-linings, whatever we can say by making reference to we can equally well say by referring to hole-linings.

If not material parts of objects, holes could be “negative” parts (Hofmann and Richards 1985), albeit not of the holed objects itself, but of a theoretical entity which occupies the whole of the convex hull of a holed object, intuitively, the geometrical result of “wrapping up” the body and filling the whole content of the spatial region so defined. One (or more) parts of this super-object would coincide with its hole(s); these would be negative parts of the super-object, i.e., parts that correspond to a local privation of matter. The advantage of this conception is that holes are treated as any other part, and the simple framework for treating them is mereology, restricted to a specific domain. Intuitions about the super-object, however, are unstable: is it material through and through, with negative parts as just abstractions, indicating operations performed locally on the matter the super-object is composed of? Or is it partly material and partly immaterial? In such a case the account comes close to the immaterial view of holes.

The immaterial view of holes holds that they are immaterial objects, whose notion is molded upon that of a material object up to the requirement of material constitution. Holes are then a subclass of ordinary objects – those that are not made of matter (a variant construal is that they are *made of* space, space being here considered as a peculiar sort of matter, as per substantivalist accounts). Their not being made of matter (or their insensitivity to matter) explains some of the particular intuitions about their identity: filling and emptying a hole does not change or destroy it: a screw is kept in place precisely by the geometry of the hole it fills; keeping the hole’s geometric continuity up to topologically invariant deformation makes it survive, and so on. It should however be noted that material constitution overdetermines identity intuitions in the case of material objects (witness the puzzling reception of Theseus’ ship or of statue/matter cases), whereas holes may take advantage of the fact that intuitions about their identity are principally controlled by functional properties – as they simply lack a material side. On other accounts the immaterial nature of holes could render other intuitions indeterminate, as happens with modal properties of holes. Thus we said that it is *prima facie* reasonable to claim that holes are individually existentially dependent on the objects they are in (“*this* hole could not have been in *that* object”), but as a matter of fact our modal intuitions could be not sufficiently determinate precisely because holes are immaterial.

Of course, being recognized as immaterial, and coincident with regions of space, holes can be directly construed as (non-object) bounded regions of space; a view that is open to the objection that holes can move around, whereas regions of space cannot.

Finally, holes could be not individual, but relations – between an object and a region of space.

An overarching error account of holes takes stock of some of these difficulties and proposals and must of necessity accompany some of them. Accordingly, holes would be illusions; mere projections of a cognitive apparatus that deploys ready-made solutions to figure-ground problems and represents space as populated primarily by objects. The error account would add nothing philosophically interesting to a general projectivist construal of material entities – and there are indeed reasons to consider that material bodies themselves are mind-dependent – were it not for the fact that projectivism about holes could be paired with realism about objects, thereby circumscribing metaphysical oddity to a local matter of fact.

## **Shadows**

Common sense and pictorial practice distinguish between cast shadows, those that are projected on walls, and attached shadows, the dark side of objects (further complexities can be ignored here); let us just consider cast shadows. Shadows are usefully characterized, *prima facie*, as holes in light; they therefore inherit some of the metaphysically interesting features of holes, whereby the role of the material object host is now taken by light. In particular, like holes, shadows are dependent entities, they have location, shape and size, and they have individuation principles that mimic those of holes (for instance, they can merge and split.)

However, shadows have a couple of added complexities, due to the dynamic nature of light, and to the more structured system of their dependencies upon other entities (not only upon light itself, but also upon an obstacle that blocks light transmission, and upon a screen). Consider them in turn.

First, a shadow can only exist because an object, an obtruder, blocks light; the obtruder must be exposed to light. It may be left open where the cast shadow “begins”, whether immediately beneath the lit up surface or immediately beyond the dark surface, i.e. whether the obtruder is spatially included or not in the shadow. (Is the interior of an object shaded by its lit-up surface?)

Second, a shadow exists insofar as light is locally missing. And as our spontaneous measure of light’s presence or absence is perceptual, access to the light-shadow demarcation is typically constitutive of our attribution of shadow character to dark zones of our environment (this explains why we do not spontaneously conceptualize night as a shadow: we do not see the light night is carved into). However not all local deficiencies of light count as shadows: traceability back to an obtruder remains a necessary condition.

Now, if light is totally prevented from reaching the shadowed area (bar physical complications related to scattering) it is indeterminate whether this prevention will be exerted indefinitely in space or whether it will stop being exercised when the shadow is cast on a screen. There is here an intuition that the spatial features of shadows are supported by causal features, however broadly construed. Leonardo claimed (perhaps metaphorically) that shadows are carried around by ‘shadow rays,’ the negative counterpart of light rays; a modern variant suggests ‘shadowons’, negative counterparts of photons (Talmy 2000: 115). If this were the case, then one could ask whether shadow rays penetrate objects or are stopped by them. After all, if a shadow ray is the privation of a determinate light ray, then shouldn’t this privation extend as far as the light ray would have extended? (Notice the analogy with the above question of whether holes construed as negative parts belong to objects).

A classical shadow puzzle arises from this indetermination. If in order for an object to be able to cast a shadow, it must intercept light, and if the local absence of light is indeed stopped by the first screen encountered (the one on which we see the shadow projected), then it becomes indeterminate which of two serially interposed obtruders are responsible for shading a given area. The first in order of distance from the light source, call it A, is the one that intercepts light, but then it cannot cast its shadow through the second, B (Todes, Daniels 1975). From an observer situated at the screen, it is indeterminate whether the eclipsing body is A or B; and it is indeterminate whether it is A or B that is seen, assuming that their profiles visually coincide. Endorsing Leonardo’s shadow rays only delays a resolution of the problem: a causal theory of perception must now accommodate ‘negative carriers’ (Sorensen 1999) ultimately denies the indeterminacy and argues that A is casting the shadow and is seen as it is the causal agent, the light blocker. Indeed, dimensions of indeterminacy abound for shadows, so much so that even the shadow/light distinction can be conceptually blurred: if the obtruder is a piece of green glass, its projection on the screen (a green expanse) can equally well be considered as a green shadow or as a green light spot (Casati 2002).

## **Conclusions**

The entities described here are all superficial in the sense that they have to do with surfaces; this fact shows up in the analysis of their structure. Other minor entities will display other complexities (related to time, in the case of events). Minor entities are an enrichment of the ontology whose benefits appear to outweigh the costs in some cases (especially in terms of descriptive power, as it is hard to describe a superficial, perforated and eclipsed world without referring to surfaces, holes and shadow). In other cases, the intrinsic difficulties encountered in the analysis of these entities may prove too taxing. A general, unified account of the metaphysically interesting features of the minor entities described here may be beyond reach given the peculiarities of each kind. Still, some of the tensions



documented here may tentatively be ascribed to the fact that the concepts we use to deal with surfaces, holes and shadows each tap into different representational systems, and thus generate not obviously compatible representations of one and the same entity. The abstract notion of a surface could be tributary of a type of spatial representation that undergoes tighter constraints than the type of causal representation that, supposedly, underscores the material-causal conception of a surface. In the case of holes, a tension arises between holes considered as (almost) objects and holes considered as (qualified) regions of space; as well as from consideration of holes as the result of creating empty space by deleting a portion of an object. For shadows, these difficulties are compounded by the intuitive inscription of a strong causal component into the behavior of shadows. This component is likely to misfire when it comes to describing the ‘interaction’ of a shadow with the surface it is cast upon— where the only fact of the matter is the absence of an interaction between *light* and the surface in question.

Thus, much as descriptions of reality in terms of minor entities can provide useful and poignant shortcuts (for instance, by avoiding complex references to the topological structure of the surface of a multiply perforated object), the underlying metaphysics requires fine-tuning and adjustments that may encounter hard to overcome conceptual limitations.

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A study of pictorial representations of shadows with a discussion of conceptual and taxonomical issues.

Giralt, N., Bloom, P. (2000). "How special are objects? Children's reasoning about objects, parts, and holes." *Psychological Science*, 11, 497-501.

Empirical evidence of similar treatment of holes and objects in infants.

Sorensen, R., 2007, *Seeing Dark Things*. Oxford: Oxford University Press.

An engaging and wide ranging account of absences such as holes and shadows, discussing the threat they pose to standard accounts of perception.