REVIEW ARTICLE

Hill on perceptual relativity and perceptual error

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Abstract

Christopher Hill's *Perceptual experience* is a must-read for philosophers of mind and cognitive science. Here I consider Hill's representationalist account of spatial perception. I distinguish two theses defended in the book. The first is that perceptual experience does *not* represent the enduring, intrinsic properties of objects, such as intrinsic shape or size. The second is that perceptual experience *does* represent certain viewpoint-dependent properties of objects—namely, Thouless properties. I argue that Hill's arguments do not establish the first thesis, and then I raise questions about the Thouless-property view and its role in Hill's defense of representationalism.

KEYWORDS

perception, spatial perception, illusion, representationalism, perspectival character

1. INTRODUCTION

Perceptual experience is a rich, insightful, and wide-ranging book. It explores such foundational topics as the nature of perceptual representation, the perception-cognition border, and the epistemic role of perceptual experience. One overarching aim is to "advance the cause of representationalism by proposing detailed representationalist accounts of the main dimensions of perceptual experience" (Hill, 2022, p. 6). We can construe representationalism as the view that the

phenomenal character of experience (what an experience is like) is determined by its content (how the experience represents the world as being). Here, I will focus on Hill's representationalist account of spatial perception.

2. PERCEPTUAL RELATIVITY

An orthodox view maintains that our visual systems form representations of external objects and properties in response to patterns of retinal stimulation. These computations issue in perceptual experiences wherein we are aware of some of the objects and properties that our visual systems represent. Hill accepts this orthodoxy but offers a novel theory of the *kinds* of properties represented in experience. Specifically: "Perceptual experience is not concerned with the enduring objective properties of objects, but rather with *appearance properties*, which I take to be viewpoint-dependent and highly volatile" (Hill, 2022, p. 32). Moreover, Hill espouses a particular brand of appearance properties called "Thouless properties".

So, we can distinguish a negative thesis from a positive thesis. The negative thesis is that perceptual experience does *not* represent enduring, intrinsic properties. The positive thesis is that perceptual experience *does* represent Thouless properties. I will consider both. I will argue that Hill's arguments do not establish the negative thesis, and then I will raise questions about the Thouless-property view and its role in Hill's broader mission of defending representationalism.

Hill's case for both theses is rooted in a doctrine he calls *perceptual relativity*:

> For any situation S, the ways objects perceptually appear to one in S are influenced by a number of factors that are independent of the intrinsic natures of the objects themselves. More specifically, … by factors of … three kinds: first, environmental conditions like distance from the object, angle of view, and lighting; second, features of peripheral sensory processors such as cone density and the tuning curves of individual cones; and third, internal conditions like attention, adaptation, and pathology. (Hill, 2022, p. 31)

It is introspectively plausible, for instance, that environmental conditions influence perceptual appearances. A coin appears one way when viewed head-on, another way when viewed at a slant.

A white coffee mug appears one way when brightly illuminated, another way when in the shade (Cohen, 2015; Green & Schellenberg, 2018; Hill, 2020; Morales et al., 2020). Hill bolsters this familiar introspective case for perceptual relativity with abundant evidence from perceptual psychology. Studies suggest that perceptually-based judgments of length (Loomis et al., 1996), shape (Johnston, 1991; Todd & Norman, 2003; Yu et al., 2021), size (Granrud, 2009), and slant (Li & Durgin, 2017) are systematically altered by shifts in perspective. I will focus on shape.

Johnston (1991) had participants view rotating cylinders at varying distances, with stereoscopic depth cues provided (Figure 1). They were asked to judge whether a given shape was perfectly cylindrical—that is, had a circular cross-section—or was "stretched" or "compressed" along the depth dimension. Johnston found that to be deemed perfectly cylindrical, a shape had to be physically compressed when it was nearby the observer (53.5cm), almost perfectly cylindrical at medium distances (107cm), and elongated when it was further away (215cm) (see Figure 2). Johnston took these results to suggest that a shape's length in depth is perceptually overestimated at near distances, approximately accurate at medium distances, and underestimated at far distances (compare Yu et al., 2021).

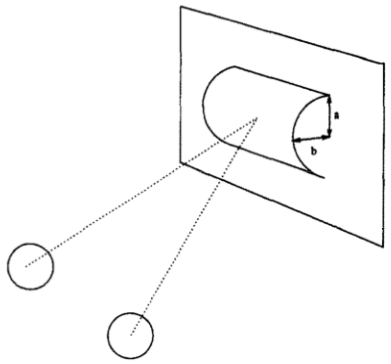

Figure 1. Stimulus from Johnston (1991). *Source:* Johnston (1991). Reprinted with kind permission of Elsevier.

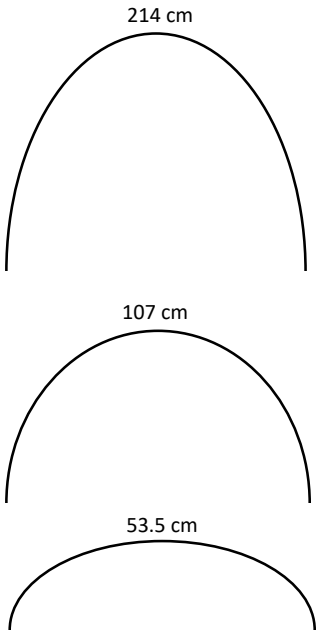

Figure 2. Cross-sections of "apparently circular" cylinders 53.5cm away (bottom), 107cm away (middle), and 214cm away (top). Redrawn based on Johnston (1991, fig. 5).

3. HILL'S CHALLENGE TO OBJECTIVISM

The foregoing findings suggest that spatial experience is perspectival insofar as objects appear different vis-à-vis shape from different perspectives. According to Hill, this challenges the view that experience represents intrinsic spatial properties:

> [A]ppearances are highly perspectival and in constant flux, while objective physical properties are comparatively stable. Moreover … appearances routinely cause us to make *substantial* errors about objective physical properties. Hence, if we were to say that experience represents objective properties, we would be saddled with the view that it systematically misrepresents them, often by a wide margin, in a number of different respects … This is not a comfortable conclusion. Our best theories of representation (e.g., Millikan (1989a), Dretske (1995), Burge (2010), Neander (2017), Shea (2018)) all speak against the possibility of representational systems that are pervasively erroneous. (Hill, 2022, p. 40)

Later he writes: “If we are aware of objective properties at all, we must achieve that awareness by moving from experience itself to non-experiential representations of some sort” (Hill, 2022, p. 46).

Call the view that perceptual experience represents at least some intrinsic spatial properties *objectivism*. In the foregoing passage, Hill contends that (i) if objectivism is true, then experience is pervasively inaccurate, but (ii) pervasive inaccuracy is forbidden by mainstream psychosemantic theories of perceptual representation, and this provides reason to reject theories that entail pervasive inaccuracy. However, both claims are open to doubt. I will start with (ii).

3.1. Psychosemantics and pervasive error

Note, first, that while pervasive misrepresentation sits poorly with theories that enshrine (say) high correlation as the fundamental mechanism of content determination, other theories are more tolerant. For example, on Millikan’s (1989) teleosemantics, a representation encodes the condition that historically needed to be present for its consumers to perform their proper function. Since this function may have been performed only rarely, it is consistent with Millikan’s view that *typically* when a representation is tokened, its content is not present (Godfrey-Smith, 1991; Artiga, 2013). Nonetheless, consumer-based teleosemantics arguably cannot handle all examples of normal misperception (Rubner, forthcoming), so this point has limited force.

More importantly, even if no mainstream psychosemantic theory accommodates pervasive misperception of shape or size, one might take this to pose a challenge for mainstream psychosemantics, not objectivism. For, we can surely have grounds to accept a theory (e.g., objectivism) that posits perceptual representations with content C, given its explanatory and predictive success, before understanding why those representations encode C rather than something else. It should arguably be up to psychosemanticists to construct theories that respect the content attributions that play an explanatory role in perception science, not the reverse.

Finally, rejecting objectivism does not obviously circumvent the problem of squaring psychosemantics with pervasive error. As Hill acknowledges, our perceptually-based judgments often concern intrinsic properties, and these judgments are systematically errant in the experiments he discusses. Assuming that psychosemantics needs to characterize not just perceptual *experience* but perceptual *judgment* too, it still must deal with pervasive error.

3.2. In defense of modest objectivism

I turn to claim (i): If objectivism is true, then experience is pervasively inaccurate. I argue that certain forms of objectivism can accommodate Hill's evidence without embracing pervasive inaccuracy. According to what I will call *modest objectivism*, perceptual experience represents both *abstract* intrinsic properties of objects and *determinate* viewpoint-dependent properties of objects (perhaps even Thouless properties), and is pervasively inaccurate in neither respect.

Shape properties are more or less abstract according to the range of transformations under which they remain invariant. *Metric* properties are invariant only under some subset of the similarity transformations (rigid transformations and uniform scaling), and include properties like *circularity* and *squareness*. *Affine* properties remain invariant also through shearing or stretching (e.g., *parallelogram* or *triangle*). *Topological* properties are still more abstract, surviving any transformation that preserves continuity (for example, *closed figure* or *torus*).

Hill's evidence primarily concerns judgments about metric properties. However, experimental evidence suggests that we also perceive abstract, non-metric shape properties, *and* that perceptually-based judgments about these properties are generally accurate (Green, 2017). Changes that alter an abstract shape category (e.g., introducing a corner to an object, or poking a hole in it) are more salient (say, detectable) than changes that do not, even when both involve the same amount of pixel-level distortion (Lazerva et al., 2008; Kayaert & Wagemans, 2010; Amir et al., 2012; Todd et al., 2014). Moreover, paradigm visual processes like apparent-motion perception and object tracking are more disrupted by changes in abstract shape properties than mere metric changes (Chen, 1985; Zhou et al., 2010). And responses in canonical visual brain areas, such as inferotemporal cortex, are modulated more by changes that alter abstract shape than by equal-magnitude changes that do not (Kayaert et al., 2003, 2005).

Furthermore, perceptually-based judgments about abstract shape properties are generally accurate. Phillips et al. (2003) showed participants complex, undulating surfaces like that in Figure 3. In one condition, they placed dots to indicate certain metric features—namely, depth maxima and minima (points either nearest or farthest from the viewer). These features are unstable under both rotation and affine transformation. Predictably, participants were highly inaccurate in identifying them. In another condition, participants indicated the locations of intrinsic ridges and valleys on the surface. These features are invariant under affine transformation, and were marked highly accurately. Such findings have been taken to support an abstract, "qualitative" shape

representation that is noncommittal about precise metric features, but encodes coarse patterns of convexities/concavities across a surface (Todd & Petrov, 2022).

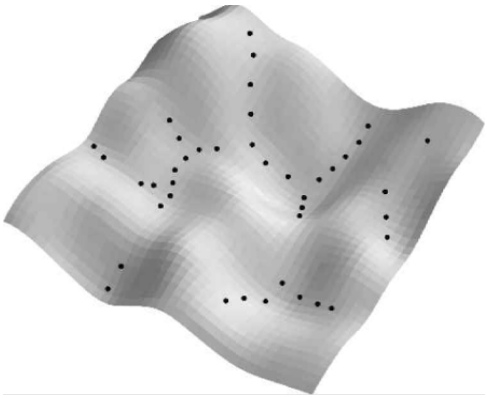

Figure 3. Stimulus from Phillips et al. (2003). *Source:* Phillips et al. (2003). Reprinted with kind permission of Springer.

The upshot is that people are indeed bad at judging intrinsic metric properties, like the exact *depth* of a concavity, but rather good at judging abstract shape properties, like the mere *presence* of a concavity.

One might suggest that abstract shape properties are represented in high-level vision, but do not enter the contents of perceptual *experience* (as Hill occasionally suggests (2022, p. 53)). However, such properties plausibly *are* represented in experience. Not only are two objects more discriminable when they differ in abstract shape, the experiences of the two are also more dissimilar. Consider Figure 4. The triangle on the top-left is, pixel-wise, equally different from the triangle in top-middle and the trapezoid at top-right. But the experiences of the two triangles are clearly more similar than the experiences of the triangle and the trapezoid. An attractive explanation is that perceptual experience represents both abstract shape and more determinate metric properties. (Such metric properties may be either intrinsic or viewpoint-dependent properties, as far as this argument is concerned.) Experiences that differ in the representation of both abstract and metric properties are more dissimilar than experiences differing only in the latter respect.

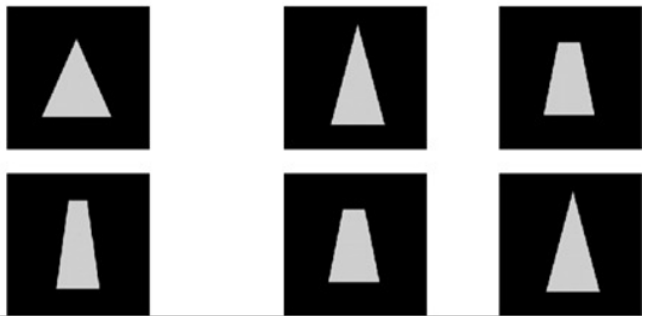

Figure 4. Both rows show, on the left, a *base* figure, and then two transformations of the base. The change that disrupts the figure's number of sides (far right) is more salient than the change that only disrupts metric features (middle). *Source:* Kayaert & Wagemans (2010). Reprinted under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs 3.0 License.

Thus, while perceptually-based judgments of metric properties are often inaccurate, judgments about abstract shape properties are not. The evidence does not support pervasive error in the perceptual representation of these properties. So, even if we concede that pervasive error is ruled out on psychosemantic grounds, modest objectivism remains viable.

4. THOULESS PROPERTIES

I turn to Hill's positive thesis. Hill contends that perceptual experience represents *Thouless properties*, which are claimed to be outputs of "partial constancy functions" (2022, p. 45). These functions yield values intermediate between an object's intrinsic properties and those of its retinal image (compare Thouless, 1931). An object's *Thouless size* is smaller than its intrinsic size, but larger than its retinal-image size or subtended visual angle. As the object recedes, its Thouless size shrinks, but not as rapidly as its retinal image. More precisely, Hill characterizes Thouless sizes as functions of visual angle and distance from a viewpoint: "The Thouless size of an object x with respect to viewpoint y is F(v, d), where v is the visual angle x subtends with respect to y and d is information pertinent to the distance from x to y" (2022, p. 45).

Hill's view neatly accommodates evidence that apparent size shrinks with distance. However, as he acknowledges, apparent size is affected not only by viewpoint, but by internal factors like adaptation (Zeng et al., 2017) and attention—wherein attended objects appear larger

than unattended objects (Anton-Erxleben et al., 2007). Merely relativizing Thouless properties to viewpoints does not explain *these* forms of perceptual relativity. For, suppose that every object has a single Thouless size relative to any viewpoint. Given that objects look larger (and thus presumably appear to have a larger Thouless size) when attended than when unattended, even while viewpoint is held fixed, perception must misrepresent the Thouless sizes of either attended objects or unattended objects. Whichever option Hill chooses, rampant perceptual error is reintroduced—i.e., either perception pervasively misrepresents the sizes of attended objects or it pervasively misrepresents the sizes of unattended objects—and the Thouless-property view confronts the same predicament as objectivism.

Hill might avoid this unwelcome consequence by holding that every object has *many* Thouless sizes relative to each viewpoint[1]—perhaps as many as there are functions from visual angle and distance to scalar values. Our perceptual systems "select" which Thouless-size value is represented on any occasion, with different values selected depending on conditions of attention or adaptation.

However, without some way of restricting an object's range of Thouless sizes, it becomes difficult to recognize *any* cases of size illusion. Consider the Jastrow illusion (Figure 5). Intuitively, we suffer a perceptual error: Object B appears larger than object A, when really they are the same size. But if the present interpretation of Hill is correct, then the case is not illusory after all. Both objects have many Thouless sizes relative to your viewpoint. So, plausibly, object B has a Thouless size that is larger than one of object A's Thouless sizes. Thus, your experience veridically represents B as having a larger Thouless size than A.

[1] I believe this is the most charitable interpretation of Hill's discussion of attentional effects on experience (Hill, 2022, pp. 66-68).

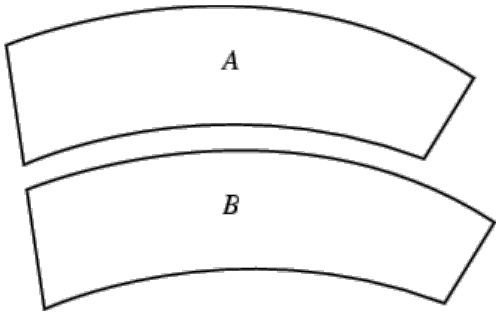

Figure 5. The Jastrow Illusion. Reprinted under the terms of the Creative Commons Attribution-Share Alike 3.0 Unported license.

Perhaps Hill would embrace this result. Indeed, he might say that size perception is *never* errant—only size *judgment*. In the Jastrow "illusion," perception is wholly veridical; the mistake lies in judging that the two objects have different *intrinsic* sizes. However, this attitude toward illusion is more aligned with contemporary naïve realist theories (Brewer, 2011; Genone, 2014) than representationalism. Indeed, perceptual error is often taken as a primary reason to *favor* representationalism over naïve realism. If Hill repudiates perceptual illusion, then it is debatable how well the account really "advance[s] the cause of representationalism" (6). Instead, naïve realists might *thank* Hill for elucidating a wide range of properties that perception never gets wrong.

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