REPLY TO LINTON:

Perspectival interference up close

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The objects in Fig. 1 clearly have different real-world shapes. But do they also have any shared shape appearance from our point of view? A longstanding philosophical tradition is divided on this question (1). But whereas most of this tradition relies on introspection, we recently took an experimental approach: When searching for head-on elliptical objects, rotated circular objects are more effective distractors than head-on circular objects, producing slower search times (2). Our interpretation is that the objects compete because they appear to share something: their "perspectival shape."

What Is Shared?

Linton (3) dissents on two grounds. First, maybe rotated circles compete with frontal ellipses because of their shared "3D visual direction," not their "2D shape." But this interpretation needn't oppose ours. Although we found it natural to invoke "the perspectival ellipse projected on our eyes" in motivating our question, our precise conclusion was more cautious: The two objects "bear a representational similarity to one another… even without specifying the dimension of such similarity, or the specific features that ground this similarity."

To refine things further: Our claim is that frontal ellipses compete with rotated circles because of some shared aspect of their appearance, where this aspect is shared from certain perspectives but not others. If that aspect turns out to be their 3D visual direction, our interpretation remains intact.

Shape Underconstancy?

Linton's second objection is empirical: Maybe the rotated circular objects didn't actually look circular, because 1) our computer-based experiments used 2D images whose pictorial cues "flatten" depicted objects and 2) our real-world experiments required a viewing distance of 250 cm, where shape from stereopsis may be compressed. Thus, rotated circles were confusable with ellipses because of underconstancy. On this objection, even subjects' near-ceiling accuracy rejecting circular objects as their targets (experiment 9: 98%) reflected cognitive judgment, not visual perception.

We worried about point 1, too; that, of course, is why we ran the real-world studies in the first place. So why use images at all? The answer is that many philosophers have claimed that 2D images don't generate perspectival appearances. For example, Kelly (4) suggests that photographs of rotated pennies wouldn't prime responses to ellipses. Furthermore, Schwenkler and Weksler (5) propose experiments using 2D images of Rubik's cubes. The core aim of our interdisciplinary project is to meet this philosophical literature on its terms; since (some of) that literature concerns 2D images, (some of) our experiments do, too.

Point 2 is different. Linton rightly notes that 3D shape can be compressed beyond 80 cm. But these findings come from cue-impoverished conditions: projected artificial stimuli in all-black rooms, with head-fixed observers and no other depth cues (6). It doesn't follow that such considerations extend to our real-world, full-cue studies.* Indeed, the same research group showed that a single additional depth cue can eliminate underconstancy even at 200 cm (9); and our experiments had even more cues than that!

Perspectival Interference Up Close

Still, the most compelling refutation would simply be to repeat our experiments at a viewing distance of 80 cm. We have now done this (10) (Fig. 2). Not only does the effect remain—if anything, it is stronger!

We thank Linton for challenging our interpretation and ultimately allowing us to strengthen it. Perspectival interference happens up close, too.

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*Incidentally, this is the same reason Linton's own proposed experiment couldn't decide the present issues. Our claims, like those of Kelly (4), Locke (7), Schwitzgebel (8), and so on, are about how ordinary objects look in ordinary circumstances—not how specks of light look under cue-impoverished viewing conditions.

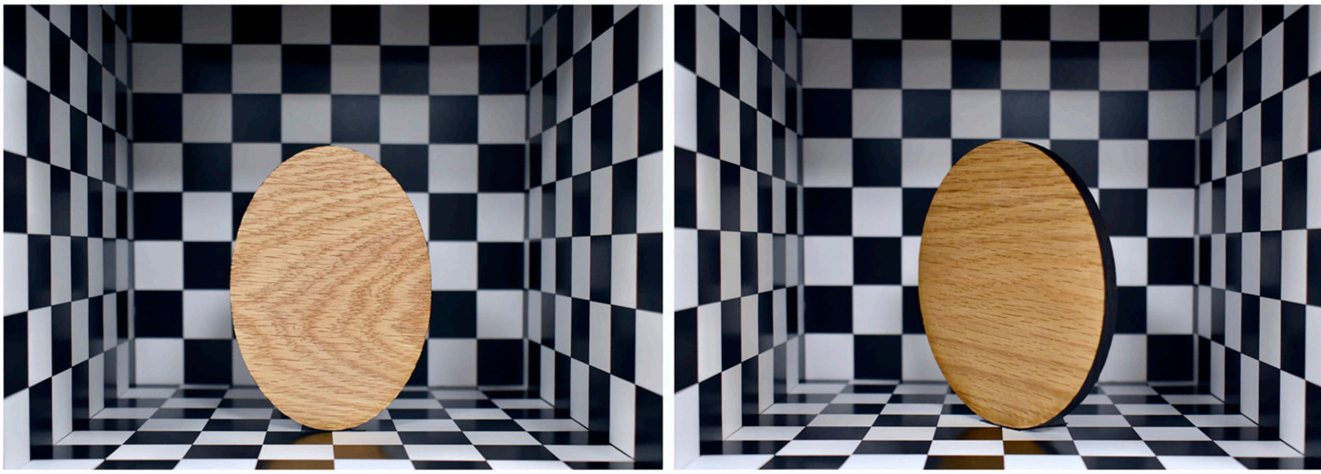

Fig. 1. We can see that these two wooden objects have different distal shapes "out there"; one is elliptical and one is circular. But is there also some aspect of their apparent shape that is shared "from here"? In Morales et al. (2), we showed that, when searching for the lefthand object (a head-on elliptical disk), the righthand object (a rotated circular disk) competes for attention and slows search.

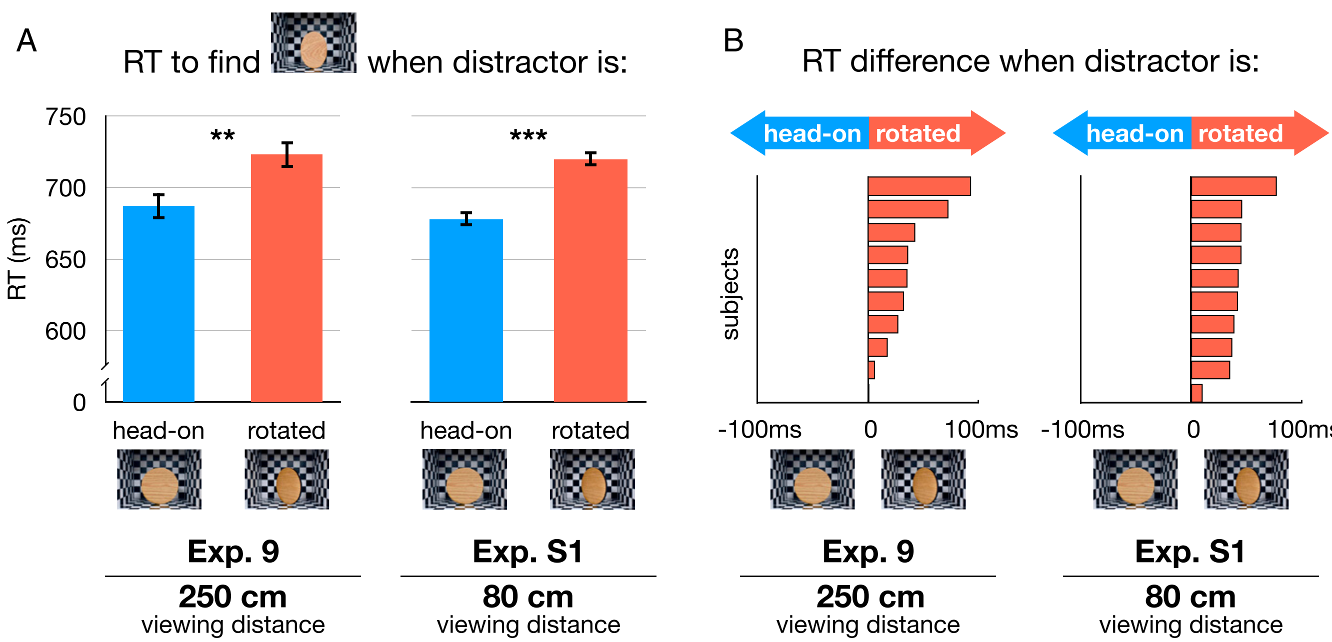

Fig. 2. (*A*) In experiment 9 of Morales et al. (2), subjects were slower to find a head-on elliptical disk when its competitor was a rotated circular disk than when its competitor was a head-on circular disk (*Left*). Here, we present a follow-up study (experiment S1) showing that this pattern of interference arises not only at a viewing distance of 250 cm but also at a viewing distance of 80 cm, where shape constancy may be more reliable (3, 6) (*Right*). Indeed, the effects at 80 cm (42-ms difference, $d = 2.57$) were comparable to—or, if anything, stronger than—the effects at 250 cm (36-ms difference, $d = 1.27$). Thus, the perspectival interference we observed does not appear to arise from the unreliability of stereopsis at far viewing distances. (*B*) The effect was robust across subjects, who were consistently slower to indicate the location of a head-on elliptical coin when the distractor was a rotated circular coin than when the distractor was a head-on circular coin. The graph plots the difference in response time (RT) between these two conditions, with each bar representing one subject. $^{**}P < 0.01$; $^{***}P < 0.001$.

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