A “living” supplement to:

Morales, Bax, & Firestone (2020)

“Sustained representation of perspectival shape”

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Jorge Morales^{a,b,c}, Chaz Firestone^{a,d,e}

^a*Department of Psychological & Brain Sciences, Johns Hopkins University, Baltimore, MD 21218*

^b*Department of Psychology, Northeastern University, Boston, MA 02115*

^c*Department of Philosophy, Northeastern University, Boston, MA 02115*

^d*Department of Cognitive Science, Johns Hopkins University, Baltimore, MD 21218*

^e*Department of Philosophy, Johns Hopkins University, Baltimore, MD 21218*

Morales, Bax, and Firestone (2020) reported that rotated circular objects compete for attention with head-on elliptical objects, and on this basis argued that some perspectivally shared aspect of their shape appearance is psychologically represented. Since then, a robust secondary discussion has emerged, often with suggestions for follow-up experiments and analyses. This document is thus a “living” supplement to Morales et al. (2020), reporting the results of some of these follow-ups as we conduct them. We will update the document as our work on this topic continues.*

*Do you have a suggestion for a follow-up? Contact Jorge Morales (jorge.morales@jhu.edu) or Chaz Firestone (chaz@jhu.edu), and it just might appear here!

1. Perspectival interference up close

1.1. Introduction

Morales et al. (2020) report that head-on elliptical objects are harder to find among rotated circular objects than among head-on circular objects, as indicated by slower search times. They attribute this slowdown to the perceived similarity between a head-on elliptical disk and a rotated circular disk — in particular, to that aspect of their appearance that is shared from some perspectives but not others.

However, Linton (2021) suggests an alternative: Since the viewing distance of Morales et al.’s real-world studies (Experiments 8 and 9) was 250cm, and shape from stereopsis is compressed beyond 80cm (Johnston, 1991), it could be that the rotated circular objects actually looked compressed in depth and so competed with elliptical objects because of their compressed distal appearance, rather than anything to do with their perspectival appearance. On this objection, even the fact that subjects showed near-ceiling accuracy rejecting circular objects as their target (e.g., 98% in Experiment 9 of Morales et al.) doesn’t indicate distally circular perceived shape, since that performance could still reflect cognitive judgments of circularity, rather than visual perception of circularity.

We worry that this objection paints an incomplete picture of the literature on shape constancy at different distances. Linton is right that 3D shape can be compressed beyond 80cm; but he leaves out that these findings arise from highly impoverished viewing conditions: projected artificial stimuli in an all-black room, with a head-fixed observer and no other depth cues (Johnston, 1991). It needn’t follow that the same considerations extend to the full-cue environment of our real-world studies.¹ Indeed, the same research group has also shown that a single additional depth cue can eliminate underconstancy even at viewing distances of 200cm (Johnston et al., 1994); and our experiments had even more cues than that!

Still, a more compelling refutation of the viewing-distance worry is simply to repeat our real-world experiments at 80cm, which is the viewing distance at which previous work reveals neither underconstancy nor overconstancy even under reduced-cue conditions (Johnston, 1991). We report this new experiment here.

¹Incidentally, this is the same reason Linton’s own proposed experiment couldn’t decide the present issues. Our claims, like those of Smith (2002), Schwitzgebel (2006), Kelly (2008), Schellenberg (2008), Cohen (2010), Schenkler and Weksler (2019) and even Locke (1975), are about how ordinary objects look in ordinary circumstances — not how specks of light look under cue-impooverished viewing conditions.

Figure 1.1: (A) Sample configuration. Two shelves with eight elliptical and circular coins were placed in cubbies with checkerboard patterns. Each cubby had a pair of LEDs, and one LED served as the central orienting cue. Subjects sat 80cm away from the shelves. (B) Task design. After the orienting cue between the two shelves blinked for 1,500 ms, one cubby from each shelf was cued (by having its LED turn on). One of the cued cubbies always contained an elliptical coin, and the other cued cubby always contained a circular coin (either head on or rotated, which was counterbalanced). Subjects pressed one of two buttons to select the shelf with the cued elliptical coin (Left or Right). Auditory feedback signaled the correctness of their response.

1.2. Methods

The setup and procedure for this experiment was almost identical to Experiment 9 in [Morales et al. \(2020\)](#), where full details about the methods can be found. Here we summarize the most important elements of the task design and highlight the specific differences of this experiment.

All data and code supporting this experiment can be found at <https://osf.io/thj6y/>.

1.2.1. Stimuli

Sixteen wooden laser-cut “coins” — eight elliptical and eight circular — were placed in two shelves. Each shelf contained four head-on elliptical coins and four

circular coins (two head on, two rotated) (Figure 1.1A). Importantly, unlike Experiments 8 and 9 reported in Morales et al. (2020), where the shelves were 250cm away from the far end of the table where subjects viewed the stimuli, in the present experiment (Experiment S1), the shelves were placed at an 80cm viewing distance. All the coins were carefully angled to look either head on or rotated 45° from the subject’s chair at this specific viewing distance.

Figure 1.2: (A) In Experiment 9 of Morales et al. (2020), 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 graph). Here, we present a follow-up experiment showing that this pattern of interference arises not only at a viewing distance of 250cm, but also at a viewing distance of 80cm, where shape constancy may be more reliable (Linton, 2021; Johnston, 1991) (right graph). Indeed, the effects at 80cm (42ms difference, $d = 2.57$) were similar — or, if anything, *stronger* — than the effects at 250cm (36ms 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 graphs plot the difference in RT between these two conditions, with each bar representing one subject.

1.2.2. Procedure

On each trial, LEDs were used to cue two cubbies (one from each shelf), one containing an elliptical coin and the other a circular coin (either head on or rotated). The subject’s task was to press a button to indicated which shelf (left or right) contained the cued cubby with the elliptical coin (Figure 1.1B). After 6 practice trials, there were 256 experimental trials divided in 4 blocks. Each block had a

different configuration of coins, which was set by the experimenter at the beginning of each block (all subjects experienced the same 4 configurations, with two possible orderings counterbalanced across subjects).

1.3. *Results*

Even at a closer viewing distance of 80cm, the pattern of results from previous experiments was replicated. Subjects were slower to select the shelf with the cued elliptical coin when a rotated circular coin was cued on the other shelf (720 ms) compared to when a head-on circular coin was cued on the other shelf (678 ms), $t(9) = 8.12$, $p < 0.001$ (Figure 1.2A). All subjects trended in the expected direction. (Figure 1.2B). Accuracy was near ceiling (mean correct responses = 97%).

1.4. *Discussion*

These results generalize our finding even further: Not only do these perspectival interference effects show up with 2D images containing a variety of static and dynamic monocular depth cues (Experiments 1–7 of Morales et al., 2020), and not only do they arise with real-world objects while the subject is constrained by a chinrest (Experiment 8) or unconstrained (Experiment 9), but they also arise at multiple viewing distances, including a viewing distance of 80cm where shape constancy should be nearly ideal. In other words, perspectival interference happens “up close” too!

1.5. *Publication Information*

The results of this experiment, along with a short discussion, are published as:

Morales, J., Bax, A., & Firestone, C. (2021). Reply to Linton: Perspectival interference up close. *Proceedings of the National Academy of Sciences*, 118(28):e2025440118.

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