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Size Illusion, Distance Illusion, and Terrestrial Passage: Comment on Reed

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Two assumptions of Reed's (1984) terrestrial passage theory are questioned. First, Reed assumes that the moon's failure to increase in visual subtense while elevating is accounted for strictly by perceptual distancing. This allows a formal account of the moon distance illusion, but at the expense of a compelling explanation of the moon size illusion. Second, in order to explain the distance illusion, Reed assumes that all objects, regardless of their perceived altitude, are perceived to start from a common point at the horizon. Several alternative application of Reed's terrestrial-passage foundation to the actual illusions are suggested.

Reed's (1984) fundamental assumption is simple and reasonable: that as a result of everyday terrestrial experience, observers treat the moon as an object in terrestrial passage. The perceptual system thus insists that the moon comply with the geometrical rules of terrestrial passage.

Normally, an increase in an object's elevation[1] is associated with an increase in the object's visual subtense. The perceptual system can interpret the moon's failure to exhibit this behavior in one (or both) of two ways without abandoning the supposition of terrestrial passage. Either the moon can be experienced as distancing as it ascends or it can be experienced as becoming physically smaller.

This ingeneous foundation represents a major advance in dealing with both the moon illusion and with associated perceptual phenomena involving reported distance to the sky (e.g., Baird & Wagner, 1982). At the very least, it provides an experiential basis for the "flattened dome" explanations of the past. However, the foundation can be applied to the actual illusion data in a variety of ways, and the manner in which it is applied by Reed seems problematical. In this article I raise two objections to Reed's treatment.

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Which Illusion Does Reed Explain?

There are purportedly two moon illusions: a size illusion and a distance illusion.

The size illusion—that the moon appears to shrink as it rises from horizon to zenith—is robust and compelling. Aside from its timeless role in human culture, there are data in the psychology literature that firmly demonstrate it (e.g., Holway & Boring, 1940a, 1940b; Kaufman & Rock, 1962; Rock & Kaufman, 1962).

The distance illusion—that the moon appears closer at horizon than at zenith—is less robust. To the best of my knowledge, no systematic data have been collected to describe the distance illusion, and unlike the size illusion, it does not seem to be universally rooted in the human experience. Nonetheless, investigators assume that it exists (e.g., Baird, 1982, p. 304; Baird & Wagner, 1982).

Reed applies his framework to both illusions. In his fourth premise (pp. 492–493) he states that "Because natural objects characteristically retain dimensional stability, failure to achieve the projected subtense while increasing elevation is perceptually equivalent to distancing." He continues the argument in his fifth premise: "Because celestial objects do not change visual subtense with elevation, their appearance in the course of rising is perceptually equivalent to distancing of a terrestrial, dimensionally-stable object."

[1] Reed's (1984) terminology will be used through.

These arguments explain the distance illusion. What about the size illusion? In the second part of Reed's fourth premise he states that "Such a failure [of visual subtense to enlarge] is most likely to result in the impression that the subtense has become smaller because distancing of natural objects . . . also decreases subtense."

Despite Reed's assertion that "natural objects characteristically retain dimensional stability," it is commonly reported that the moon does seem to change its physical size; that is, unlike most objects it does not appear to be "dimensionally stable." That is exactly what makes the illusion so surprising; perceptual experience clashes with intellectual knowledge that the moon cannot be shrinking. In short, Reed carefully explains the distance illusion, but at the expense of the size illusion, which is relegated almost to an informal speculation.

Horizon Distances

Reed assumes that the perceptual system maintains the integrity of the moon as an object in terrestrial passage by experiencing it as distancing during its ascent in such a way as to maintain a constant visual angle. The curves necessary to achieve this resolution are, according to Reed, ellipsoids. Examples of these ellipsoids are the curve in Reed's Figure 1 labeled "apparent path" and the three outer curves in his Figure 5. A point on one of these ellipsoids is further from the observer at zenith than it is at horizon; hence, the account of the distance illusion.

However, calculation of these ellipsoids requires an implicit assumption; that is, objects of different perceived (terrestrial) altitudes are all at the same perceived distance when they appear on the horizon. This assumption is reflected by, for example, the convergence of the two outer right-hand curves of Reed's Figure 5 at the horizon line. It is a puzzling assumption. As indicated in Reed's Figure 2, an object at a lower altitude would be physically closer when it appears on the horizon than would an object at a higher altitude. Why then should not an object perceived lower to begin with also be perceived closer at the horizon? If such were true, then the "apparent paths" necessary to maintain a constant visual subtense would, for the two objects in Figure 2, describe concentric semicircles, each resting on the points where the appropriate indicated path intersects the horizon line. This would be a formulation based on absolute apparent distance. In contrast, Reed's formulation is based on relative apparent distance; everything appearing at the horizon is perceived as arising from the same place no matter what the perceived altitude, yet subsequent perception takes perceived altitude into account in accordance with the growth curves of Reed's Figure 3.

Conclusion

It seems that Reed's interpretation of his own excellent foundation is more complicated than it need be. First, it explains the somewhat dubious distance illusion at the expense of the more robust size illusion. Second, it does so only by the use of the equal-distance-at-horizon assumption that is by no means self-evident.

It may be more profitable to view Reed's foundation as a mechanism to explain the flattened bowl conception that, one way or another, has been used in various accounts of the moon size illusion. The mathematics that Reed uses to fit the Boring (1943) and Holway and Boring (1940b) data can be applied exactly as they are now. The only change is conceptual; instead of claiming that the observers saw the moon as distancing, the interpretation would be that they saw it as maintaining a constant altitude, but physically shrinking. This interpretation is more closely tied to the experimental paradigm in which the observers were asked to—and did—adjust the perceived size of the moon, not the perceived distance.

Alternatively, one could pursue Reed's interpretation, but formulate a compromise model in which perceptual distancing does accompany ascent, but at a slower rate than was assumed by Reed. By this solution, the moon would appear both to recede and to grow smaller as it rose from horizon to zenith. To fit such a model, parametric data on the distance illusion, similar to those obtained by Boring on the size illusion, would be required.

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