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The moon illusion

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Abstract. The phenomenon of the enlarged appearance of the sun and the moon at the horizon is attributed to the long distance realized by the vision with the help of a perspective view. The shrunken view of these objects when overhead has been traced to the limitation of binocular vision in the absence of perspective.

Key words : moon illusion

1. Introduction

The moon, as well as the sun and the constellations, appear much bigger at the horizon than when in the high sky. The low moon is slightly more distant than the high one; the observer is brought toward the moon as the earth turns, and so the high moon is a little larger. This difference, however, amounts to less than two per cent and is, therefore, negligible. The moon illusion is not an atmospheric phenomenon, and its explanation must be traced to the human eye.

An estimate of the size of an object depends upon the apparent angular size of the object and upon its distance as perceived by us. Binocular vision and perspective help us in estimating the distance. We suggest that the moon illusion stems from the inherant limitations in the visual perception of distance.

2. Binocular vision and perspective

Monocular view has no perceptual depth and consequently studies all objects according to the magnitudes of their apparent angular dimensions in proportion to the magnitude of the angular field of vision irrespective of the depth or the distance. One eyed people, therefore, have no such illusion.

In the case of the binocular vision, two eyes separated by 65–70 mm view the object at slightly different angles. The two images are superposed in the brain. The distance is estimated on the basis of the differences in these two images and also on the background perspective. If objects of the same size are viewed at different distances, the more distant one subtends a smaller angle at the eye, but the vision perceives the true size since the distant object forms the same proportion of the extending perspective as the nearer one. The vision has learnt the perceptual scaling (Gregory 1967).

3. Factors limiting the visual estimation of distance

The resolving power of the eye plays an important role in limiting the visual estimation of distance. The average size of a light sensitive cell in human retina is about 0.004 mm, which determines the resolving power of 1 arcmin. This angle corresponds to a separation of 2 mm at a distance of about 7 m. Two lines drawn 2 mm apart are barely visible as two from this distance. Clearly, if the images formed at each eye are identical within this margin, the binocular vision is of no help in estimating the distance. The limit of binocular vision corresponds to a distance at which the two eyes subtend an angle of 1.5 arcmin. This distance limit is 150–170 m for the range 65–70 mm distance between the two eyes. Beyond this distance the perspective is the only factor which assists the estimation of distance. Contrasts of light and shade and tints of colour affect the estimation of distance based on perspective alone. This is the reason why distance is better understood on land than on sea which loses much of its contrast beyond some distance, where it appears to rise like a mound.

Our relative motion and consequent parallax displacements of objects also assist in discerning a distance. The relative distance of remote lamps at night are better understood when we move parallel to the plane of view of the lamps.

4. Distance of the sky

The distance to the horizon is realized through the perspective of the terrestrial scene. In the case of the sky overhead, the perspective is absent and one is left to discern distance within the efficiency of the binocular vision. All distant objects appear to be at the limit of binocular vision. Thus an aeroplane flying overhead appears nearer and intrinsically smaller. Same is the case with the terrestrial scene observed from an aircraft. Artificial stars produced by placing illuminated pinholes at the focus of a telescope objective, and viewed by both the eyes without the intervention of an eye-piece appear at about the same distance as the real stars in the sky.

A very dark night sky appears hemispherical with a radius of 150–170 m determined by the limit of binocular vision. The sky during a clear day, on the other hand, appears saucer-shaped, sloping to meet the horizon which is extended beyond these limits due to the advantage of perspective vision.

5. The moon illusion

The light beam from the sun or moon is a cone with its apex at the eye. The estimated size depends on the estimate of its distance. The distance to rising or setting moon is estimated higher at the limit of the perspective vision and the inferred size would clearly be larger. As the rising moon gains altitude, the perspective is lost and the apparent distance is limited by binocular vision and the inferred size would be smaller. If the perspective view of the horizon is completely removed by a very deep filter in front of the eyes, the rising or setting moon appears of the same size as at a higher altitude.

Reference

Gregory, R. L. (1967) *Eye and Brain*, World University Library, London, pp. 151–54.