Stimulus location in egocentric space as a determinant of apparent visual size

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Four separate groups of subjects were presented with vertically oriented visual stimuli which moved toward and away from them over a distance of 1-50 ft. There were two such stimuli, a tall one and a short one. The stimuli were viewed in well-articulated settings. Groups 1 and 2 observed them in an open field, and Groups 3 and 4 viewed them in a well-lit corridor. Both stimuli rested just above the ground plane. The tall one extended overhead, whereas the top of the short one was well below eye level. Groups 1 and 3 observed the moving targets from a standing position and reported on any changes in apparent size. Groups 2 and 4 viewed the short target only, both when standing and seated. When subjects were seated, the top of the small stimulus extended above them. It was found that, regardless of the setting (i.e., outdoors or in a corridor), an overhead stimulus was seen to shrink as it moved away from and grow as it approached the subject. Just the opposite occurred when the upper edge of the target was below eye level.

Broscole (1980) proposed that we judge the sizes of objects in relationship to our own heights, and that our bodily size is represented by the space that separates the ground plane from the eye-level position. It would follow, then, that the size of an external visual stimulus would be determined by the amount of space that it occupies between the ground and the eye level. Therefore, a stimulus lying below the level of the eyes would be judged to be short, and one extending above eye level would be seen as tall. If this thinking is correct, then short objects should appear to vary in size with changing distance quite differently than tall ones. Let us expand upon this reasoning.

As a short object moves off into the distance, its image decreases on the retina and it is seen to rise up with the ground. If that object rests upon the ground, then the change in proximal stimulation could be attributed to the perspective of the ground plane. As the object rises with increasing distance, its upper edge gradually approaches the eye level, so that it progressively occupies more and more space between the ground and the eye-level position. Accordingly, a short stimulus should be seen to grow with increasing distance from the observer and, conversely, to shrink with decreasing distance. The opposite case should hold for a tall stimulus.

Just as with a short stimulus, a tall one is seen to rise with increasing distance, and its retinal image diminishes. Because most of the change in proximal stimulation could be ascribed to the perspective of the ground, that object should be seen to remain relatively constant. Unlike the short stimulus, however, the upper edge of the tall one approaches eye level with increasing distance. Therefore,

it should be seen to shrink as it moves away and to get larger as it approaches. Thus, the apparent sizes of short and tall stimuli should vary differently as a function of changing distance.

If the size of a visual stimulus is assessed by the amount of egocentric space that it occupies, then it would follow that the apparent size of that stimulus may be altered by modifying body position. Therefore, for example, an object might look short when the observer stands erect, and tall (because it extends overhead) when the observer is seated. If this is the case, then the same stimulus may be seen to grow with increasing distance when viewed from a standing position and, to shrink when the observer is seated. All of these speculations were tested by presenting observers with short and tall moving stimuli in two articulated settings. One was on a level plane under clear, open skies, and the other was in a well-lit corridor.

METHOD

Subjects

Twenty-nine males and 3 females participated in this study. Their mean age was 35.0 years, and their average height was 5.91 ft. All subjects were warehouse or office employees, and were naive as to the purpose of the study.

Stimuli

The stimuli consisted of two lengths of aluminum channel that were 0.5 in. wide. One rod was 3.5 ft long and represented the short stimulus. The other was 6.0 ft long and was used as the tall stimulus. They were both painted orange, so as to be easily visible at long distances. They were mounted separately, in a vertical orientation, on the chassis of a remotely driven motorized cart. The cart was built from a 1:12-scale kit model of a Porsche (Model BSR, Type 934) and was operated by a Fatuba two-channel radio-control unit (Model FF-72G-27). The lower edges of the stimuli were 1 ft above the ground (when mounted), so that the short one was clearly below the eye level of every subject and the tall one always extended overhead. The radio-operated cart developed a constant speed of 29 in. per sec 8 sec after the start.

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Stimulus Settings

Open-field conditions were run on the level rooftop of a warehouse, with a relatively unobstructed surround. Subjects observed the moving stimuli along a clear path 304.8 ft long and 61 ft wide. At the far end of the path there was a 5-ft-high wall that did not intrude upon viewing the target.

The enclosed setting consisted of an office-building corridor that was 86.4 ft long and 6.1 ft wide. There was brown wall-to-wall carpeting on the floor and five lighting fixtures on the white ceiling. The walls were papered in light orange. There were two closed doors on the left of the corridor and one at the end.

Procedure

The subjects were assigned to four separate groups, with 8 observers in each. Group 1 viewed the stimuli in the open field under two conditions. In Condition 1, they saw the short rod travel back and forth three complete times in a straight line over a distance of 1-50 ft away from them. In Condition 2, the tall rod was viewed in the same fashion. The order of the two conditions was counterbalanced over subjects. The subjects' task was to report verbally on any apparent size change on a continuing basis.

Only the short stimulus was presented to Group 2, which observed it in the open field. The subjects viewed the stimulus from a standing position in Condition 1, and while seated on a 10-in.-high stool (which made it appear overhead) in Condition 2. The order of the two conditions was counterbalanced over subjects. All other details were the same as for Group 1.

Groups 3 and 4 viewed the stimuli in the enclosed corridor. The procedure used for Group 3 corresponded to Group 1. The procedure for Group 4 was run the same way as that for Group 2.

RESULTS AND DISCUSSION

Seven of the 8 subjects in Group 1 saw the short stimulus grow as it moved away and shrink as it came closer. The apparent changes in size occurred between 1 and 22.8 ft away from the subjects (on the average), with the size of the stimulus seeming to remain constant at the greater distances. Presumably, the subjects could not detect a change in the level of the top of the rod relative to eye level beyond 22.8 ft, resulting in size constancy. These 7 subjects were astonished by the observed effect, because it violated their cognitive expectation of how apparent size should have changed as a function of distance. The remaining subject did not see the stimulus change size at all. It is interesting that not one subject saw shrinkage with increasing distance and growth with decreasing distance. According to the binomial test, a significant number of subjects (7 of 8) obtained the predicted effect ($p < .05$). As expected, every subject in Group 1 saw the tall rod shrink as it moved away and grow as it came closer ($p < .01$ according to the binomial test).

Group 2 was presented with the short stimulus only, in the open field. When viewing from a standing position, all 8 subjects saw the rod grow as it moved away and shrink as it approached ($p < .01$). This time the effect occurred between 1 and 22.6 ft away from the subjects. When seated, however, all subjects saw the rod (which now extended overhead) diminish in size as it moved away and grow as it approached ($p < .01$).

Essentially the same results were obtained in the enclosed corridor. All subjects in Group 3 saw the short rod increase in size as it moved away and diminish as it re-approached ($p < .01$). The effect occurred up to an aver-

age distance of 22.4 ft from the subject. Just as with Group 1, all subjects perceived the opposite effect for the tall stimulus ($p < .01$).

In Group 4, 7 subjects saw the short target grow in size as it moved away and shrink as it returned, when it was observed from a standing position ($p < .05$). The effect occurred up to 19.8 ft from the subject. The stimulus appeared to remain constant up to 25.4 ft away for 1 subject. It seemed to shrink as it moved beyond that point, and to grow as it approached that point from 50 ft away. When seated, every subject saw the same effect as had Group 2 ($p < .01$).

It is of particular interest that essentially the same results were produced in the corridor as in the open fields. This indicated that apparent size in a complete enclosure was not determined relationally by the visual boundaries established by the encapsulating field. To the contrary, it appears that the surround transmitted only one salient cue, namely, the ground plane. This in turn combined with the eye level to give the observer a sense of his/her own height, which was then used as a standard for judging the size of other objects. Our results have consistently supported the hypothesis that apparent visual size is egocentrically determined.

The results of the present experiment are fully consistent with everyday experience, which reveals that the perception of the sizes of objects is highly contingent upon their egocentrically referenced location in space. As we look down upon others from the top of a staircase or a ladder, they certainly look smaller than they would if we were on a level plane, or if our positions were reversed. Certainly, objects look bigger when observed from a seated position, as compared to when standing, as is commonly experienced in trains and buses. In fact, the memory of a scene from childhood is much larger than the experience of the same scene visited later in life. Perhaps the only difference in size perception between a child and an adult is that the adult views the world from a higher plane than does the child. If this is the case, then it would follow that individual differences in size perception may be understood in terms of variations in people's heights. It would be interesting to compare size perception of children to that of comparably sized adults, such as midgets. In this case, maturation and past experience would vary, with bodily height held constant. As a final note, it would be equally as important to systematically study size perception with movement along inclined and declined planes, because in these instances the separation between the ground and the eye level could not possibly be representative of egocentric space. Obviously, more research in the area is required.

REFERENCE

- BROSGOLE, L. (1980). Size of perception from an egocentric point of view. *Perceptual & Motor Skills*, 50, 698.