APPARENT VISUAL SIZE AS A FUNCTION OF DISTANCE FOR CHILDREN AND ADULTS

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There is some question in the literature as to whether size-constancy varies with age.[1] Data are, however, lacking from an investigation of size-constancy for which a wide range of distances is available and for which a functional relationship can be plotted. The present study was designed to obtain such results.

Apparatus and procedure. The procedure was modeled after that used by Holway and Boring.[2] A series of standard stimulus-objects, made from 1-in. diameter wooden dowels, were prepared such that at the distances used in the study, the objects subtended a visual angle of 0.96° at *S*'s eye. The comparison-object, also a 1-in. diameter dowel, was so arranged that the visible portion of its length could be continuously varied by moving it up or down through a hole cut in the center of a board. The remainder of the comparison-object was hidden from *S* by a suitably placed curtain. *S* was seated at a distance of 5 ft. from the comparison-object, which was approximately at eye-level. The standard objects were fitted into small black wooden blocks and mounted on a black metal stand 3 ft. from the floor in front of and slightly to one side of the comparison-object.

The experiment was conducted in a room 108 x 22 ft. From *S*'s position three windows were visible on one side of the room and one at the extreme end. There were several pieces of furniture visible along the walls. Illumination was provided by six 100-w. bulbs in addition to the windows, and the experiments were conducted in the early afternoon and only on sunny days.

Five distances were used; 10, 30, 60, 80, and 100 ft. For each distance *S* made four judgments, two ascending and two descending. (The actual manipulation of the comparison stimulus was done by *E* at *S*'s direction.) The distances were presented in a random order and, between successive trials with new distances, *S* was so blindfolded that he could not see *E* setting up the standard objects.

The instructions for both children and adults were as follows.

I am going to move this stick (pointing to the comparison-object) up and down. I want you to tell me when it looks as high as the one out there (pointing to the standard object).

S was told to disregard the stand or the wooden block and to base his judgments on the height of the standards. *E* avoided giving any information as to whether the

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[1] Franz Beyrl, Ueber die Grössenauffassung bei Kindern, *Z. Psychol.*, 100, 1926, 344-371; H. Frank, Untersuchung über Sehgrössenkonstanz bei Kindern, *Psychol. Forsch.*, 7, 1926, 137-145; Die Sehgrössenkonstanz bei Kindern, *ibid.*, 10, 1928, 102-106; Wilhelm Burzlaff, Methodologische Beiträge zum Problem der Farbenkonstanz, *Z. Psychol.*, 119, 1931, 177-235.

[2] A. H. Holway and E. G. Boring, Determinants of apparent visual size with distance variant, this JOURNAL, 54, 1941, 21-37.

standards were of the same or different sizes. *S* was also instructed to make all judgments with binocular regard and to wear glasses if needed.

The *S*s were 13 in number (8 boys, ranging from 7 to 9 yr. of age, and 5 men, from 18 to 24 yr. of age) all resident at a summer camp. The men were told they were to serve as controls for the experiment with the children. For the boys, the experiment was part of a 'scouting' game which included outdoor as well as indoor estimates of the sizes of various objects.

Results. The results for the children are given in Table I and for the adults in Table II. Both sets of data are plotted in Fig. 1. On this plot a horizontal line

TABLE I

MATCHED SIZE (IN INCHES) OF STANDARD STIMULUS-OBJECT AS A FUNCTION OF DISTANCE (Children)

S	Age (in yr.)	Distance of standard (in feet)				
		10	30	60	80	100
		Size of test object (in inches)				
		2	6	12	16	20
1	9	1.3	3.3	2.9	3.5	3.3
2	8	1.9	4.3	7.8	8.2	9.2
3	8	1.5	3.1	5.3	6.4	5.5
4	7	2.9	4.1	6.6	7.8	9.4
5	8	3.1	5.1	9.9	11.1	13.1
6	8	2.5	5.2	8.3	8.0	8.3
7	8	2.1	4.8	11.1	8.2	10.9
8	9	.8	1.1	1.4	1.2	1.1
Mean		2.0	3.9	6.7	6.8	7.6
SD		.8	1.3	3.3	3.6	4.0
Brunswik ratio		1.00	.58	.52	.39	.35

represents the law of the visual angle; a theoretical condition in which perceived size can be predicted on the basis of geometrical optics. The law of size-constancy is represented by a line of slope 0.017 (tan 0.96°). If perceived size were independent of distance, *i.e.* perfect size-constancy, the data would fall along this theoretical function.

It can be seen from Fig. 1 that the data for the adults fall very close to the prediction in terms of size-constancy as previously reported by Holway and Boring. The data for the children however, fall at positions on the matched size-axis closer to the line representing the law of the visual angle. Differences between the means of matched sizes for adults and children were calculated for all distances above 10 ft. A Mann-Whitney non-parametric u-test indicates that these differences are significant ($u<0.01$ for 30, 80, 100 ft.; $u<0.05$ for 60 ft.).

Discussion. The results of the present investigation demonstrate closer agreement with the law of size-constancy for a group of adults than for a group of children. Such results are consistent with the conclusions of Beyrl, but differ with respect to the magnitude of the difference in size-constancy.[8] As has been pointed out by

[8] Beyrl, *op. cit.*, 369.

Frank, all of Beyrl's *S*s, including his 2-yr. old children, demonstrate rather high constancy.[4] Brunswik ratios computed for his data, which were obtained at distances between 6 and 37 ft., for the 2-yr. old group range from 0.77 to 0.92 for a disk test-object, and from 0.87 to 0.95 for blocks. For his 8-yr. old group (n=2) the ratios vary from 0.97 to 0.99 for both kinds of test-objects. Brunswik ratios for the children in the present study are 1.00 at 10 ft., 0.58 at 30 ft., and drop to 0.35

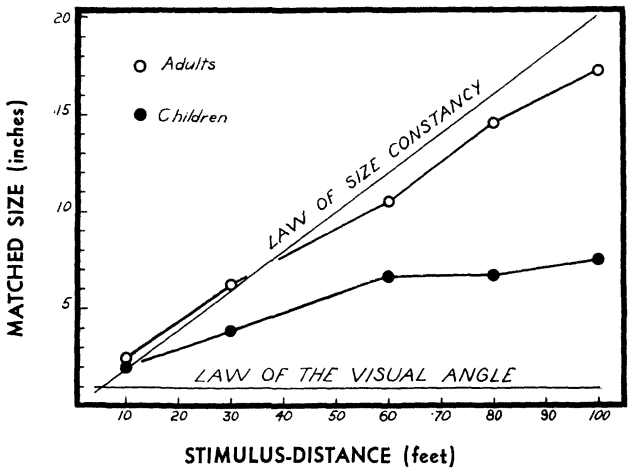

FIG. 1. MEAN MATCHED SIZE AS A FUNCTION OF STIMULUS-DISTANCE FOR A GROUP OF ADULTS AND OF CHILDREN
The Size of the Test-Object Was Adjusted so as Always to Subtend a Constant Visual Angle.

at 100 ft. Thus, the present study agrees with Beyrl's conclusion that size-constancy is not as well developed in children as in adults, but differs in that for comparable stimulus-distances the children show less constancy than did Beyrl's.

In addition, the present experiment, utilizing a greater range of distances, indicates that the differences between children and adults increases with the distance of the test-object. This can be clearly seen from the shape of the curve in Fig. 1. The function for the adults is nearly linear, and lies close to the line representing the law of size-constancy. The curve for the children rises less rapidly with distance and approaches a limiting value at about 60 ft. The differences between the mean matched size at 60 and 100 ft. are not significant for the children ($p>0.05$) and are significant for the adults ($p<0.01$).

With respect to inter-*S* variability, the present results are consistent with those of previous investigators. As has been pointed out by Smith, studies of size-constancy typically demonstrate an increase in variability with distance.[5] That this also holds

[4] Frank, *op. cit.*, 1928, 103.
[5] W. M. Smith, A methodological study of size-distance perception, *J. Psychol.*, 35, 1953, 143-153.

true for the present investigation is evident from inspection of the standard deviations in Tables I and II.

The present results, obtained over a range of 90 ft., demonstrate that the functional relationship between matched size and distance is different for adults and children. Such results are interpreted as supporting the view that size-constancy increases with age.

Summary. The function relating matched size to distance was determined for groups of children and adults. The *S*s matched a comparison-object to one of a series of standard objects located at various distances but so adjusted in size as always to subtend a constant visual angle. The results for the adults lie close to the theoretical line representing the law of size-constancy. The results for the children were more in agreement with the law of the visual angle. The adult-curve is nearly a straight line, while that for the children approaches a limiting value at 60 ft. These data are viewed as lending support to the thesis that size-constancy increases as a function of age.

TABLE II

MATCHED SIZE (IN INCHES) OF STANDARD STIMULUS-OBJECT AS A FUNCTION OF DISTANCE
(Adults)

		Distance of standard (in feet)				
S	Age (in yr.)	10	30	60	80	100
		Size of test object (in inches)				
		2	6	12	16	20
1	20	2.2	6.4	8.9	15.1	15.7
2	24	2.6	6.2	7.9	9.8	15.0
3	18	2.4	5.9	10.4	11.6	12.3
4	20	2.3	5.6	13.6	18.8	21.1
5	19	2.9	7.4	12.4	17.8	22.6
Mean		2.5	6.3	10.6	14.6	17.3
SD		.36	.78	2.3	3.8	4.3
Brunswik ratio		1.50	1.06	.87	.91	.86