# The influence of surface complexity on judgments of area[1]

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*The apparent size of squares was determined as a function of physical area and of surface complexity using the method of magnitude estimation. Apparent area increases as a power function of physical area with a slope of about 0.90. The judged areas also increased as a function of complexity of patterns upon the surface, the most complex surfaces being judged approximately 30% larger than the most simple surfaces.*

It has been noticed by one of the authors (C.K.G.) that certain surface qualities affect the apparent size of buildings. When cultural mores have motivated a desire for grandeur in certain periods of history, such as the Italian Renaissance, architecture has responded with, among other things, an increasing complexity of form and surface. In more recent times, Louis Sullivan and others have employed a technique that also appears to affect apparent size. This technique involves the compositional contrasting of small, rather complex and detailed areas of ornament with larger, less complex areas. Modern buildings, often stripped of surface ornamentation, present a smaller apparent size than is actually the case. The psychophysical method of magnitude estimation (Stevens, 1957) appears to be an appropriate means of submitting these observations to an experimental test.

The quantification of size judgments has revolved mainly around the phenomenon of size constancy and other size-distance relationships (Holway & Boring, 1941; Gilinsky, 1955; and others). The development of the method of magnitude estimation led many investigators to examine the relationship of estimated area to the physical area of the stimulus (Ekman & Junge, 1961; Stevens & Guirao, 1963; Teghtsoonian, 1965). The relationship obeyed Stevens's power law and yielded exponents that ranged from 0.70 to 1.0, depending upon the experimental conditions and instructions (Teghtsoonian, 1965).

The foregoing experiments used simple, unpatterned stimulus configurations. Although Gibson (1950) emphasizes the importance of texture in perception, most of the published papers dealing with surface arrays are limited to qualitative descriptions. Baird (1965) has studied the estimation of area and distance of patterned stimuli (black and white squares). His Os were asked to judge the physical area of single or multiple black regions on a white surface viewed with monocular regard through a reduction tube. Under these conditions, the results did not fit a power function well.

The aim of the present experiment was to relate size estimation as a function of surface patterning, using the method of magnitude estimation. Specifically, two hypotheses were tested: (1) A uniform pattern does not greatly alter apparent size, and (2) a contrast of large and small compositional elements increases apparent size. It must be pointed out that these are two-dimensional surface considerations, not three-dimensional spatial considerations. The results, therefore, should not be interpreted as affirming or denying theories of three-dimensional space perception.

## METHOD AND PROCEDURE

Four groups of nine square cards, having the following characteristics, were prepared, as illustrated in Fig. 1: Group 1—no pattern, blank white; Group 2—uniform pattern, white with a random distribution of black squares of equal size; Group 3—white, with a random distribution of black squares, circles, and triangles, all of approximately equal size; Group 4—large and small compositional elements, white, with a random distribution of black squares, circles, and triangles of three different sizes. The ratio of the black pattern to the total area of the card was constant (20%) for all cards. For Groups 3 and 4, the number of squares, circles, and triangles of the same area was equal for all cards. Each group consisted of a graduated series of nine cards having areas of 16, 30, 49, 72, 100, 132, 169, 209, and 256 sq in. The constructed patterns were photographed and printed onto Kodak Poly-contrast paper to obtain uniformly black images on uniformly white paper. Reproduction ratio was held constant. The sheets were dry-mounted on stiff cardboard.

The cards were presented to the Ss seated 5 ft ± 3 in. from a 30%-40% gray painted wall, where the cards were mounted, one at a time. The center of the cards remained at approximately eye level. The illumination of the room was uniformly controlled at an average level.

The Ss were asked to assign numbers that appeared to be representative of the area of each card. They were requested not to think in terms of standard units of measurement and to use any number, smaller or larger than one, that seemed to fit the area of the card. They were cautioned to judge the area of the card and not the area of the pattern. All cards of a specific group were presented three times for estimation according to a predetermined random order. Geometric means of the final two estimates were used for the analysis of data. The sequence of group presentations was also random. Stimulus cards, concealed from the S's view, were presented one at a time by the E, who was also concealed from view. No time limit was imposed for viewing each card, but most judgments were made within 1 min. The Ss closed their eyes during card changes.

Six undergraduate students (three men and three women) were used. All reported having 20/20 vision, several with corrective lenses. With the exception of one S, art or architecture students were not used since some sources indicate that people visually trained give visual data that is somewhat different from that given by untrained Ss (Thouless, 1932).

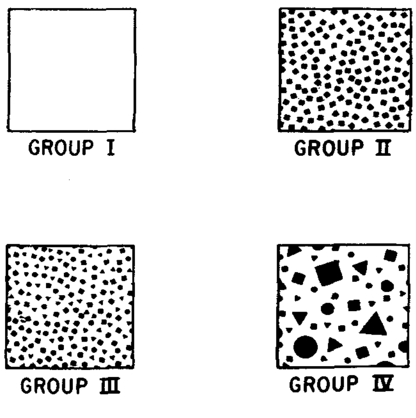


**Fig. 1. Surface configurations of the judged cards. The patterns from Group 1 through Group 4 represent an increasing order of complexity. Each group contained a series of nine differently sized cards.**

  

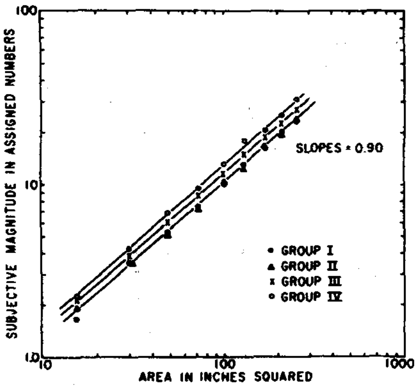


**Fig. 2. Subjective magnitude of squares as a function of physical area with complexity of the surface patterns as the parameter. Complexity of the surface pattern increases from Group 1 (no pattern) through Group 4 (contrasting large and small elements). Estimated area increases with surface complexity.**

## RESULTS AND DISCUSSION

The responses from Runs 2 and 3 were averaged for each S (geometric mean) and plotted. The geometric means obtained for each pattern group are shown in Fig. 2. Straight lines were fitted by the method of least squares. The slopes for all groups may be described as power functions with exponents of approximately 0.90. The addition of patterns of varying complexity does not appear to have an effect upon the rate of growth of apparent size, but the differences in the intercepts of the functions indicates that pattern does influence the apparent size of the stimulus. Both hypotheses are verified by the results. The close correspondence between the curves for Groups 1 (no pattern) and 2 (uniform pattern) confirms the first hypothesis: The addition of a uniform pattern to a surface does not alter its apparent size. The estimates of Group 4 cards (large and small compositional elements) were approximately 30% greater than those of Group 1 (no pattern), confirming the second hypothesis: A contrast of large and small compositional elements increases apparent size. The estimates of Group 3, which had a pattern of intermediate complexity, fell approximately midway between the simplest and most complex patterns used.

The results clearly support the view that judged area is a power function of physical area. The value of the exponent falls within the range of previously obtained slopes, but it is difficult to make a direct comparison because a wide variety of instructions and experimental conditions had been used. Ekman et al (1956) and Ekman and Junge (1961), using the method of ratio estimation, obtained values of 0.86 and 0.92, respectively, for estimated area of squares. Stevens and Guirao (1963), using the method of magnitude production with a standard, obtained an exponent of 0.70 for squares, and Teghtsoonian (1965) obtained a value of 0.81 for irregular polygons by the method of magnitude estimation with a standard.

## CONCLUSIONS

The results support the view that estimated area is a power function of physical area. Furthermore, increasing the amount of complexity (pattern or texture) of the judged surface tends to increase estimated area. While a uniform pattern does not appear to increase the apparent area of a surface, the contrasting of large and small compositional elements significantly increased the apparent area of the surface. Caution must be observed in directly translating these results of two-dimensional surfaces to three-dimensional buildings, but the observation that ornamentation appears to affect the apparent size of buildings would seem to be consonant with the results of the present study.

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## NOTES

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