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THE ASSOCIATION VALUE OF RANDOM SHAPES [1]

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It is well known that verbal materials vary in meaningfulness or association value, and that these variations are related to learning and retention. Patterns and shapes may vary similarly; however, little systematic control over such variation has been exercised in studies of perceptual learning and retention. Indeed, little effort to standardize such materials has been expended (cf., e.g., the discussions by Hilgard [1951, p. 547] and Graham [1951, pp. 911–915]).

A number of experiments have appeared in which random shapes have been used as stimuli in tasks involving perceptual learning and retention. Random shapes have also been employed in studies of mediated transfer and "predifferentiation."[2] In most of these studies, control has not been exercised over possible effects of association value of the shapes upon performance of *S*s. The present experiment was undertaken to provide a pool of random shapes with known association value for use in studies of the effects of certain stimulus variables and pretraining upon recognitive performance. It was considered desirable to provide for variation of association value and stimulus complexity, in order to assess the interaction of these two variables as determinants of recognition.

METHOD

Materials.—The stimuli were 180 random shapes, 30 for each of 6 levels of complexity, as defined by Attneave (1957).[3] Each shape was constructed by first plotting points, selected by use of a table of random numbers, on a 100 × 100 grid, and then connecting them according to the following rules: (*a*) the most peripheral points were first connected to form a convex polygon. (*b*) The interior points were then chosen at random and connected one at a time to the sides, which also were labeled and chosen randomly. (*c*) After each connection as above, the line which defined the side to which the last point was connected was removed and the process repeated for the next point. Either 4, 6, 8, 12, 16, or 24 points were used for a given shape.

This method corresponds to Method 1 of a series of methods suggested by Attneave and Arnoult (1956) for the construction of random shapes. Each shape was photographed (black on white) and mounted on 4 × 5-in. hardboard.

Arrangement of materials.—An arbitrary identification number and an arbitrary rank were assigned to each shape and were punched on an IBM card and on the back of each photograph. The IBM cards were then shuffled in haphazard fashion to obtain a sequence of the 180 shapes for presentation to *S*. Fifty such sequences were similarly obtained and listed by means of an IBM Model 405 tabulator. A coefficient of concordance was computed by comparing the mean rank of each shape in the sequences with the mean rank expected from a random sequence. This procedure yielded a value significant at the 22% level. The haphazardly constructed sequences were thus also

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[2] A discussion of experiments on predifferentiation and the effects of meaningfulness may be found in the article by Arnoult (1957).

[3] Complexity refers to the number of points which determine inflections on the perimeter of the shape. Attneave found a linear relation between the logarithm of the number of points and judged complexity.

considered to be random for the group of *S*s used in the experiment.

Apparatus.—The presentation apparatus was a shadow-box arrangement with a 4 × 5-in. window at the back. The photographs were placed on an inclined ledge behind the open window during exposure and were changed manually. The interior of the box (into which *S* looked) and all areas in front of the window were painted flat black. A 60-w. incandescent lamp was located above and behind the window to yield an illumination of about 35-ft.-c. on the surface of the cards, without glare. Exposure time for each card was 3 sec. Viewing distance was about 30 in. The *S*'s responses were recorded by means of a wire recorder and concealed microphone.

Subjects.—The *S*s were 50 volunteer university students, 33 men and 17 women. Four *S*s of the original group were discarded and replaced, three because they were unable to follow directions and one because he failed to complete the task.

Procedure.—After being seated in the darkened experimental room, *S* was told:

"I am going to show you a number of shapes. I will show the shapes to you during the period between buzzes, like this [two samples shown]. You will have the time between buzzes to look at each shape. Some of the shapes may remind you of some familiar object or situation while others may not remind you of anything. Your job will be to name whatever the shape reminds you of, if anything. Some of the shapes may remind you of some object or situation, but you may not be able to describe it in the short time during which you see the shapes. If the shape reminds you of something that you can describe in a word or two simply say that word or phrase. If the shape reminds you of something, but you cannot describe it in a word or two, say simply, 'Yes.' If, of course, the shape doesn't remind you of anything, say, 'No.' It is important that you say something, either a word, if the shape reminds you of something that you can describe, or 'Yes,' or 'No' for each shape that you see. Questions?"

Results and Discussion

The *S*s' responses were punched into IBM cards, which were then sorted and tabulated to obtain the following data: (*a*) the number of *S*s making associative responses to each shape, (*b*) the verbal content of each response, and (*c*) number of shapes having each frequency as in *a* above.

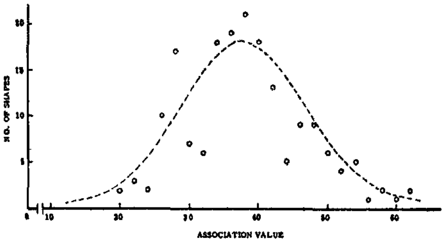

Fig. 1. Distribution of association values of 180 shapes.

Association value of each shape was the percentage of the *S*s making "Yes" or content responses to the shape. The range of percentages thus obtained was between 20% and 62% with a mean at 38%. A frequency distribution of the 180 shapes was plotted and is shown in Fig. 1. The distribution was approximated by fitting a Gaussian curve to the data, and it may be seen that the fit is a reasonably good one, with the exception of the slight skewness of the data, as shown by the excess of scores at the low end.

Consideration of the above results indicates that none of the 180 shapes was completely devoid of associations. The lowest value was 20%. Further, no shape evoked associative responses from the entire group of *S*s. This latter result is interesting in view of the strong resemblance of some of the simpler shapes (4 and 6 points) to geometric forms such as triangles, rhomboid figures, and trapezoids. Perhaps our *S*s were unfamiliar with the names of some of these figures and therefore could not report appropriately. On the other hand, those forms did not evoke "Yes" responses either. A third finding of interest was the compression of the distribution around the mean with spread at the extremes. This finding might be

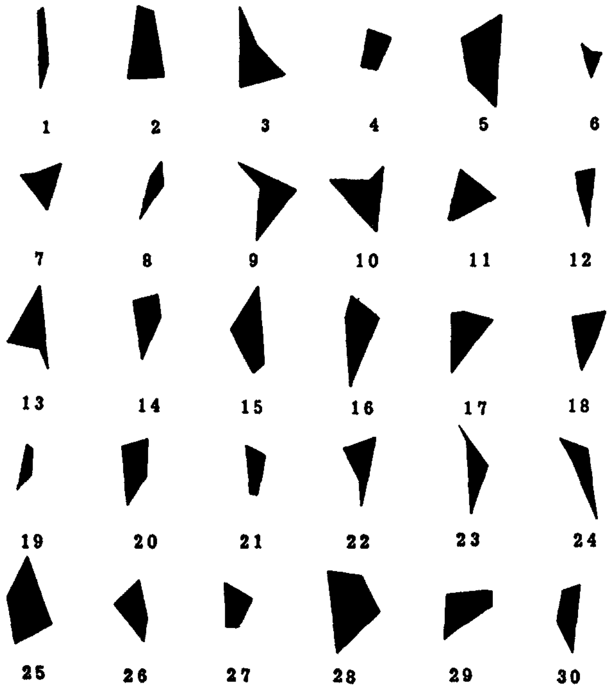

FIG. 2. Four-point shapes scaled in the study.

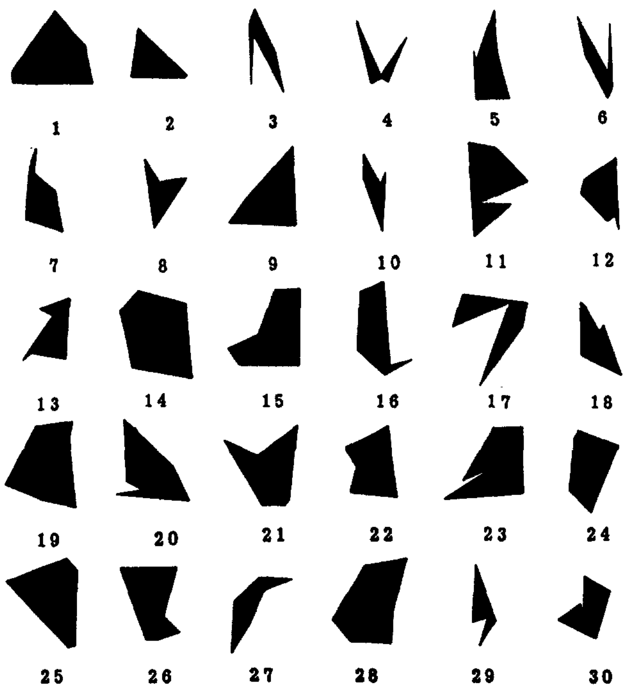

FIG. 3. Six-point shapes scaled in the study.

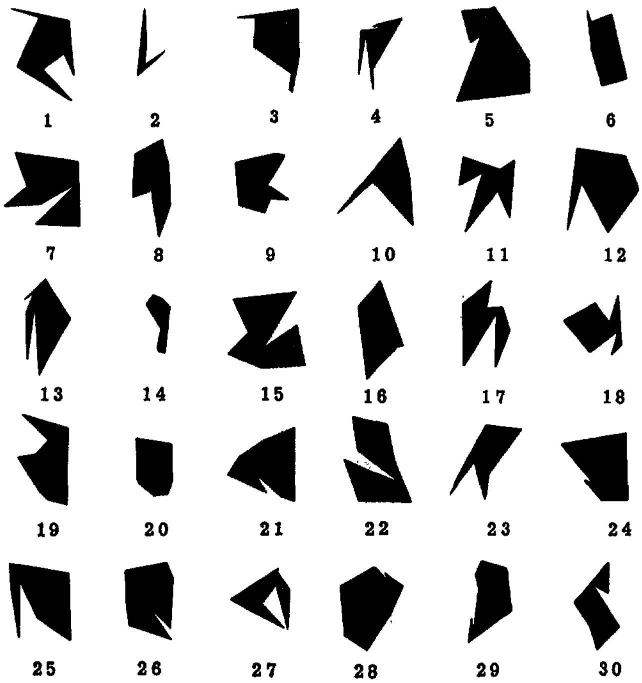

FIG. 4. Eight-point shapes scaled in the study.

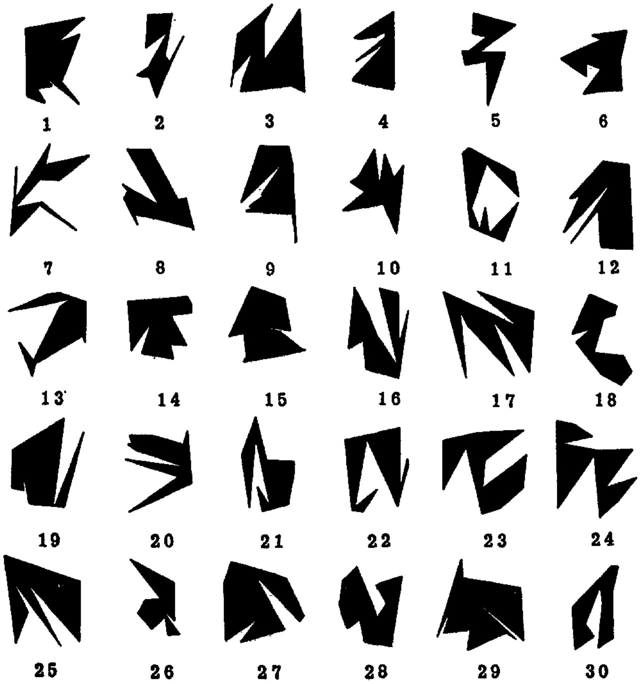

FIG. 5. Twelve-point shapes scaled in the study.

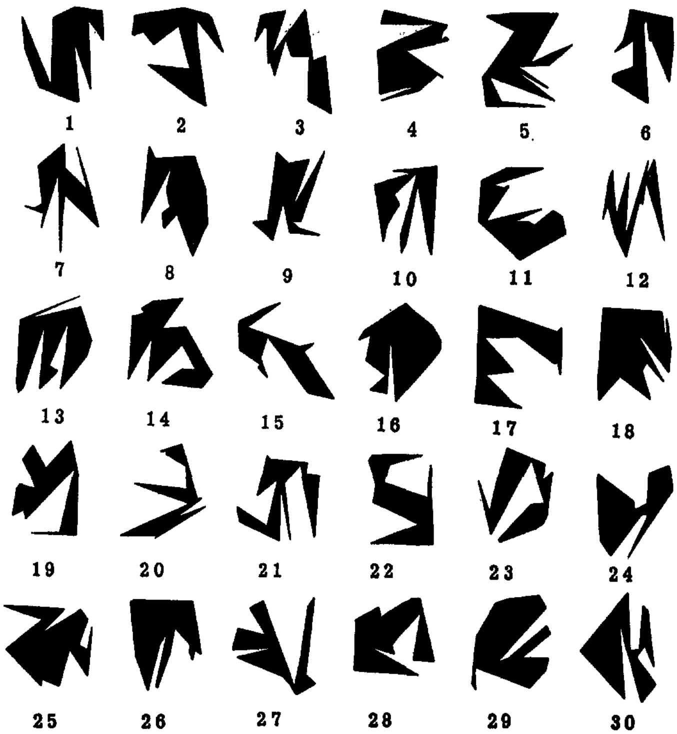

FIG. 6. Sixteen-point shapes scaled in the study.

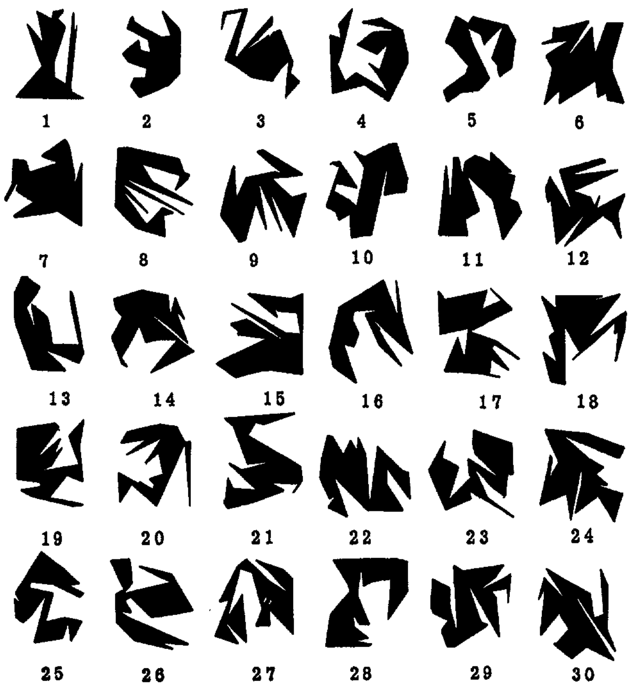

FIG. 7. Twenty-four-point shapes scaled in the study.

TABLE 1

Association Value (A), Proportion of Associations Which Were Content (C), and Heterogeneity (H) of the Content Responses, for Each of the 180 Shapes

Shape No.	4-Point Shapes			6-Point Shapes			8-Point Shapes			12-Point Shapes			16-Point Shapes			24-Point Shapes		
	A	C	H	A	C	H	A	C	H	A	C	H	A	C	H	A	C	H
1	56	32	3.7	62	33	2.7	62	35	2.9	50	32	3.3	52	27	3.6	60	33	3.9
2	54	39	3.0	58	34	2.7	58	33	3.0	48	38	2.9	50	28	3.1	54	31	3.0
3	54	31	4.1	54	33	3.7	46	24	3.0	48	35	3.5	42	33	3.6	48	25	2.7
4	52	33	3.8	54	31	3.5	44	30	3.4	48	27	3.4	42	21	3.2	48	23	2.6
5	50	36	3.7	52	35	3.8	42	31	3.0	46	30	3.6	40	33	3.6	44	25	3.0
6	50	34	2.9	52	29	3.3	42	26	2.8	46	26	3.5	40	30	3.3	42	38	3.5
7	50	36	4.1	50	34	4.1	40	30	3.0	46	26	4.4	40	28	3.1	42	24	2.7
8	48	42	2.3	48	38	4.0	38	34	3.8	42	29	3.0	38	32	2.7	42	21	2.4
9	48	31	2.9	46	39	2.9	38	32	2.9	42	26	2.8	38	32	3.3	40	35	3.4
10	48	29	3.4	44	32	3.5	36	33	2.5	40	33	2.4	38	21	3.1	40	25	3.1
11	46	39	3.1	40	40	3.3	36	28	3.1	40	30	3.5	38	16	2.6	40	28	2.9
12	46	33	3.5	40	33	3.4	36	22	3.0	40	25	3.3	36	30	3.0	38	37	3.4
13	46	28	3.9	40	33	3.4	36	22	2.5	40	25	2.5	36	30	2.6	38	29	2.5
14	46	28	3.8	38	34	2.9	34	29	2.6	38	32	3.3	36	25	2.6	38	26	3.0
15	44	34	3.9	38	29	2.8	34	24	3.0	38	29	2.8	36	22	3.1	38	24	2.3
16	44	23	2.6	38	21	2.8	32	28	2.6	38	29	3.4	36	22	3.1	36	28	2.7
17	42	40	2.6	38	26	3.1	30	23	2.8	38	24	3.1	36	17	2.6	36	19	2.5
18	42	33	2.9	38	26	2.8	28	32	3.1	36	28	3.1	34	35	3.3	34	32	2.8
19	42	29	3.3	38	26	2.9	28	32	2.9	34	38	3.6	34	29	2.6	34	29	2.4
20	42	29	3.0	36	28	2.8	28	29	2.8	34	26	2.9	34	29	2.8	34	29	3.3
21	40	38	3.5	36	25	3.2	28	29	1.5	34	24	2.8	34	18	2.6	34	21	2.2
22	40	30	3.0	34	41	2.8	28	23	3.1	32	31	2.8	32	34	3.0	34	18	2.6
23	40	30	3.5	34	38	2.6	28	29	3.1	30	13	2.0	32	31	3.3	32	34	3.1
24	40	25	2.5	34	35	3.3	28	29	3.1	28	25	2.8	32	28	1.2	30	20	2.3
25	38	26	3.1	34	24	2.4	28	25	2.8	28	25	2.1	30	37	3.1	28	25	2.8
26	36	34	3.8	30	37	2.7	28	25	2.8	28	25	2.8	30	27	2.8	28	25	2.5
27	36	32	3.2	26	31	2.0	26	23	2.2	26	42	3.4	30	27	3.1	28	21	2.6
28	36	32	3.3	26	27	2.1	26	15	1.5	26	23	2.2	26	23	1.8	28	14	2.0
29	36	29	3.0	26	23	2.6	22	32	2.8	26	23	2.6	24	25	1.8	24	25	2.6
30	28	43	2.6	26	23	2.6	20	20	1.5	20	30	2.6	22	21	1.9	22	27	2.6

interpreted as indicating that the 180 shapes have associative characteristics in a "low-medium" range and that they are somewhat more homogeneous than, for example, nonsense syllables, with respect to associations.

The shapes scaled in the study are shown in Fig. 2–7. Data concerning association value for each shape as well as the proportion of associative responses which were verbal content responses other than "Yes" and an index of the diversity, or heterogeneity, of the content responses, are shown in Table 1. The association value (A) is the percentage of the 50 *S*s responding to the shape with the word "Yes" or a verbal content word. The content value (C) is the proportion of the total percentage of responses which were words or phrases denoting associations with objects or situations. The heterogeneity index (H) is the mean amount of information per content response, computed from the entropy formula proposed by Shannon and Weaver (1949) as a measure of information.[4]

A preliminary inspection of the data indicated that shapes of high complexity tended to evoke fewer associative responses than did those of low complexity. To check this observation, a contingency analysis was conducted. The distribution was cut at approximately equal tercile levels to define shapes of high, medium, and low association values. Each of these categories was then split into six subcategories in terms of complexity, with the result as shown in Table 2. The obtained contingency chi square was 32.31 ($P < .001$).

It may be seen from Table 2 that there is a larger number of shapes of high complexity in the low association value category than in the high category, while the reverse is true for the simple shapes. This finding would tend to indicate an inverse relation between complexity and association value for the 180 shapes.

TABLE 2

NUMBER OF SHAPES OF HIGH, MEDIUM, AND LOW ASSOCIATION VALUE ARRANGED IN ORDER OF COMPLEXITY FOR CONTINGENCY ANALYSIS

Assoc. Value	Number of Points in Shapes					
	4	6	8	12	16	24
High	20	10	6	9	4	8
Medium	9	11	7	9	13	9
Low	1	9	17	12	13	13

Further preliminary inspection of the data of Table 1 and of the catalogued responses indicated that shapes of low complexity evoked not only more content responses and fewer yeses, but also responses which were reflective of their resemblance to objects. Shapes of greater complexity seemed to evoke responses of greater variety of content, in the sense that they did not reflect clear resemblances to objects. It may be that this lack of resemblance resulted in responses of greater "projective" quality (e.g., the 24-point shape No. 30 evoked the responses church, nun, branch, and city, while the 4-point shape No. 17 evoked the responses triangle, kite, sail, and pyramid).

To investigate these relations somewhat more precisely, the correlations between the pairs of variables were calculated, and these are shown in Table 3. It may be seen that the relation between Complexity (N) and Content (C) is an inverse one ($r = -.34$), while the relation between Complexity and Association Value (A) and between Complexity

[4] $H = -\Sigma p_i \log p_i$, where p_i is the probability (proportion) of content response of the ith class.

TABLE 3

INTERCORRELATIONS OF ASSOCIATION VALUE (A), COMPLEXITY (N), HETEROGENEITY (H) AND CONTENT (C), FOR THE 180 SHAPES

	N	H	C
A	−.19	.48	.35
N	—	−.22	−.34
H	—	—	.49

and Heterogeneity (H) are also negative ($r_{NA} = -.19$, $r_{NH} = -.22$). This would seem to indicate that as the shapes decrease in complexity they tend to evoke more associations, and ones which are more likely to be of greater content and heterogeneity as well. The relations between the other variables are positive and seem to indicate a general tendency for shapes of high association value to evoke responses of greater heterogeneity as well as content. This relation might be expected to occur, since there is greater likelihood of responses to be different as more persons respond to a shape, provided only that the shape does not clearly resemble a common object, as, say, a photograph of the object would.

Whatever interpretation one may make of the results, it is clear that random shapes vary with respect to the number and kind of associations they elicit. These variations may be related to the ease of learning and retention of the shapes. Association value has been treated most often in a qualitative way in studies of perceptual learning, and a more thorough account might be made of the variety of existing results in this area. By use of materials of known association value, control of this variable might be exercised, with corresponding clarity of the basis for results.

SUMMARY

Association value, content, and heterogeneity of associative responses were determined for 180 random shapes of varying complexity (number of points). Tabulations of these variables and correlations between them are presented. The results indicate a range of association value from 20% to 62% for the shapes examined. An inverse relation was noted between the complexity of the shapes and the number, content, and heterogeneity of associative responses, while a positive relation exists among the other variables, for the shapes studied. The shapes presented form a pool of materials which may be used in studies of perceptual learning and retention in which control of association value is desirable.

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