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Changes in Position of Presentation as Related to Perceptual Efficiency in Stimulus Identification*

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Little experimentation has been undertaken in the area of perception of variously positioned geometrical figures. One study concerning symmetrical figures has been reported by Ganguli (1). He investigated the problem of determination of the optimal "break" in a circle which will be perceived as a "whole" through closure tendency. The incomplete circles in his experiment ranged from openings of 0° to 45°. Individual differences were found in threshold which varied as a function of the position of the gap. Threshold values were greater for lower gapped positions than for upper gapped positions.

In a more recent study by Postman and Bruner (3), closure is studied as affected by set and response habit of S. The purpose of their experiment was to observe the effect of differences in past experience with closed and open circles on the readiness with which closure takes place when incomplete circles are presented under low level stimulation. Set and past experience were observed to affect the operation of closure. However, a possible extraneous effect of gap positioning on perception apparently was not controlled systematically in their study. It is possible that failure to control gap position may have weakened the experimental effects observed.

The Problem

The purpose of the present study is to determine any effects on perceptual efficiency of incomplete circles induced by varying gap location in a circle of uniform size. Accordingly, this experiment is designed to test the null hypothesis that visual perception of incomplete circles is unaffected by location of position of the gap.

Apparatus

The apparatus consisted essentially of a stimulus board, control panel and a Hunter Decade Interval Timer (2). Seventeen .15 amp. T47 type 6-volt miniature bulbs were mounted in ¾-inch plywood and masked by No. 2108, ⅛-inch thick green translucent

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plexiglas. Points of light ½-inch in diameter were formed by mounting the light assemblies within ½-inch holes through the plywood.

Nine circular stimuli patterns could be set up from either 16 or 17 illuminated lights. One pattern consisted of 17-light circular stimuli formed from a central light and two concentric rings spaced in one-inch increments from this central light as in figure 1.

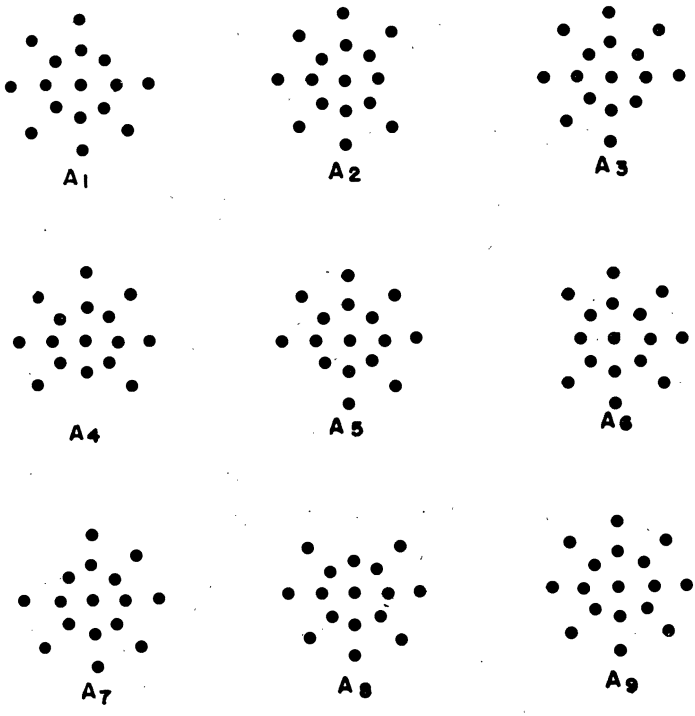

FIGURE 1

The other eight patterns consisted of 16-light circular stimuli formed from the same central light and first 8-light concentric ring, but in which the outer ring contained only seven lights. With the removal of any given light in the outer ring constituting a separate pattern, there were eight possible 16-light circular patterns as shown in figure 1. The size of the stimuli was held constant, 6-½ inches in diameter.

The stimuli were presented for a time interval predetermined from a pilot study and set to be close to the minimal threshold limit. This time interval was controlled by a Hunter Decade Interval Timer (2). The interval was measured by a Stoelting Preci-

sion Chronoscope to average .051 seconds. The time lag required for illumination of bulbs to minimally observable intensity was computed and found to average .034 seconds. Therefore the net exposure time for each stimulus was approximately .017 seconds.

Procedure

Subjects. The nine different illuminated circular patterns described were presented to twenty subjects (10 men and 10 women) for a total of 50 trials each. All subjects were students or employees of Iowa State College and were mostly below middle age.

Controls. A semi-darkened room was used for the experiment. The only source of illumination was a 6-watt colored bulb mounted centrally in a ceiling fixture.

The subject was allowed time for partial adaption to the darkened room by the criterion of successful responses to trial stimuli.

The order of series presentation was varied to avoid any possible effects of systematic replication of sequence.

The experimenter was separated from the subject by a dark curtain. S was seated in a chair equipped with a hydraulic lift which enabled raising or lowering as required to maintain a constant angle of vision. The visual angle of the stimulus pattern was 2°13′.

Method of Response Measurement. The subject recorded his response on a record sheet containing rows of eight-element circular patterns. He was instructed to encircle either the "missing part" or the entire pattern if the circle was complete. The record sheet was mounted on a specially constructed box which contained a shielded illuminated 6-volt bulb masked with glass and filter paper. Just enough light was provided to enable S to record each response accurately.

Experimental Design. As stated each S received 50 trials. Since there were 20 S's, 1,000 responses in all were recorded. Stimulus pattern A9 (see figure 1) was replicated 10 times, and A1 through A8 each was replicated five times for each subject.

Statistical Design. The statistical design was formulated a priori and is summarized as follows:

1. In terms of correct responses:
   (a) Analysis of variance to test differences in perceptual accuracy of various positions of circular patterns. Subjects and sex were also tested for significance.
   (b) Summative chi-square to test for independence of the total number of responses.

2. In terms of errors:
   (a) Chi-square to test error responses for each subject and for all subjects for, (1) errors of commission and (2) errors of omission.
   (b) Binomial probabilities for substitutional errors for each and for all subjects.

Results

Analysis of variance showed that the differences among the patterns (A1 and A9) were signicant at the one per cent level of confidence. When patterns A9 and A2 were omitted individually the obtained F ratios were significant at the one per cent level; however, when patterns A9 and A2 were omitted the obtained F

Table 1

Analyses of Variance
(Summary)

Source of Variation	
1. All patterns (A1 through A9)	F(patterns)= 23.32** F(subjects)= 3.51**
2. Patterns (A1 through A8)	F(patterns)= 3.52** F(sex) =<1.00 F(subjects)= 3.13**
3. Patterns (A1 through A9 not including A2)	F(patterns)= 22.50** F(subjects)= 3.32**
4. Patterns (A1 through A8 not including A2)	F(patterns)= 1.14 F(subjects)= 3.34**

**Significant at 1% level

was not significant (table 1). Subsequent chi-square analysis corroborated these findings (table 2). Response differences between subjects is indicated by F ratios significant beyond the one per cent level. All other analyses yielded no significant differences.

In adjacent and opposite errors S's tended to see A1 instead of A2 ($p<.09006$), A8 instead of A4 ($p<.097$) and A7 instead of A6 ($p<.007$).

Among errors of closure tendency S's showed disposition to see A9 instead of A8 ($p<.007$, A9 instead of A7 ($p<.021$) and A9 instead of A5 ($p<.076$). Finally, in errors of anti-closure tendency, S's saw A1 instead of A9 ($p<.009$) and A8 instead of A9 ($p<.030$).

A chi-square analysis of errors of omission or failure to respond revealed significance at the five per cent level; this summative chi-square for all errors was 14.217. Failure to respond to stimulus

A7 was also significant at the five per cent level. Failure to respond to all other conditions was non-significant.

The chi-square value for total correct responses was found to be 27.04 with 152 degrees of freedom. For 100 degrees of freedom chi-square is 67.3 at the .005 proportion. This result indicates an overall predominant tendency toward correct responses among S's.

Chi-square analysis of the total number of errors reveals that A2, A8 and A9 were perceived incorrectly at the one per cent

Table 2

Pattern and Summative X^2 in Terms of Errors for All Subjects (with expected error taken as total divided by the number of conditions)

Pattern	X^2	Pattern	X^2
A1	3.878*	A6	.437
A2	17.282**	A7	.005
A3	2.814	A8	.261
A4	.133	A9	25.540**
A5	1.197	Total (A1 through A8)	32.810**

*Significant at 5% level
**Significant at 1% level.

confidence level and condition A1 was a significant error at the 5 per cent confidence level (see table 2).

Summary and Conclusions

An apparatus is described for presenting nine different illuminated circular patterns at exposures of very short duration.

The stimulus is composed of points of light arranged to form two concentric rings surrounding a central point. The outer ring contains either seven or eight lights. The inner ring and central light serve as a fixation point for S. When all eight lights of the outer ring are illuminated, a complete circle is formed. With seven lights illuminated in the outer ring, a gap is formed in the circle which may be varied by changing the position of the missing light.

Twenty subjects were used each receiving 50 trials. The complete circle was replicated ten times, and each of the incomplete circles was replicated five times for each subject. Each stimulus was presented for a constant duration of approximately .017 seconds. S responses were self-recorded on a special record sheet.

Analysis of results suggest the following tentative conclusions subject to the limitation of the study as presented:

1. There are individual differences in perceptual efficiency of certain circular configurations.

2. Perceptual efficiency of a gapped circular configuration varies as a function of the position of the gap.

3. Patterns A1, A3, A5 and A8 are observed to be perceived by all S's with a high degree of accuracy, although patterns A1, A3, A8 seem to be perceived accurately partly due to a seemingly high response strength associated with these conditions (figure 2). In terms of accuracy without error pattern A5 seems to be most accurately and consistently perceived.

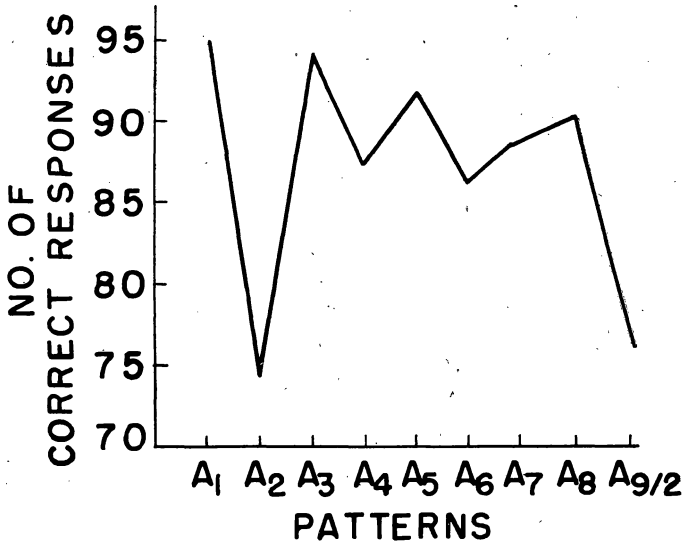

FIGURE 2

4. Several types of errors were considered: (a) adjacent and opposite substitutional errors; (b) closure substitutional errors; (c) anti-closure substitutional errors and (d) errors of ommission. These errors are explained in terms of response strength and the principles of closure.

5. Response strength seems associated with gaps presented in the upper part of the configuration, A1 and A8 patterns particularly.

6. Certain possible operational characteristics of the closure phenomenon are suggested.

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