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Randomness as an Element of Stimulus Complexity

Norman M. Kiracofe

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RANDOMNESS AS AN ELEMENT OF STIMULUS COMPLEXITY

by
Norman M. Kiracofe

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of the
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REVIEW OF THE LITERATURE

In recent years the concept of stimulus complexity has come into increased use in psychological literature. The meaning of this concept and its implementation in experimental research have taken a number of forms (Berlyne, 1958; Cooper, 1963; Dember, Earl & Paradise, 1957; Herschenson, 1964; Karmel, 1966; Sackett, Keith-Lee & Treat, 1963).

A number of definitions of stimulus complexity have been used. Cooper (1963) defines complexity in terms of the number of sense modalities stimulated. Randomness in stimulus pattern elements was used by Karmel (1966). Berlyne (1958) and Herschenson (1964) define complexity on the basis of contour. Berlyne (1960), on the basis of the uncertainty measure of information theory, has incorporated both randomness and the number of elements into an operational definition of complexity:

Other things being equal, complexity increases with the number of distinguishable elements....if the number of elements is held constant, complexity increases with dissimilarity between elements.... complexity varies inversely with the degree to which several elements are responded to as a unit.

Dember, Earl and Paradise (1957), using the assumption that an increased number of elements generates complexity, found in 12 of 13 SS that rats would shift from an area of less complexity to a more complex area when permitted to circulate freely in mazes of varying degrees of complexity.

Herschenson (1964), investigating the visual stimulus pre-

ference of human infants, found they significantly preferred the least complex stimulus when complexity was based on the number of light-dark stimulus transitions. Contrary to these findings, Berlyne (1958) reported that stimulus patterns with more contour were preferred by infants.

Studies of light and dark reared rats showed they more readily approached food in the goal box of a T maze when it was accompanied by a visually complex design on the walls of the goal (Sackett, Keith-Lee, & Treat, 1963).

Karmel (1966), working on the basis of Berlyne's (1960) discussion of stimulus complexity, tested rats and chicks for pattern preference in a visual cliff apparatus (patterns set at equal depth). He used a checkerboard pattern of 1 in. squares vs. three patterns of increasing randomness composed of the same size and number of squares. The results showed a strong preference for the checkerboard pattern ($p < .001$). Interpretation of these results, in light of the Berlyne (1958) and Herschenson (1964) definitions, indicated a response to the more complex stimulus. If the greater complexity is defined in terms of randomness, the Ss preferred the least complex of the stimuli.

Two important aspects of complexity, randomness and contour, were confounded in Karmel's (1966) study. His regular and random patterns were constructed with 50% black space and 50% white space. Using this great a pattern density, the contour (defined as the number of light-dark transitions of the stimulus pattern elements)

variable could not be held constant as randomness was manipulated.

In some preliminary studies with Japanese Quail, using a technique similar to that of Karmel (1966), it was discovered that a differential response to pairings of regularly spaced patterns with differently sized squares was demonstrated. This suggests that the size of the square textural element used in the stimulus pattern might influence the response. Walk and Gibson (1961) reported chicks preferred smaller stimulus pattern elements.

The present research project was designed to test the effects of complexity, defined in terms of an increase in randomness, on the stimulus preference of 20-hour-old Japanese Quail. The stimulus patterns were constructed so that the contour variable would be held constant as randomness was manipulated. Three sets of patterns with differently sized groups of squares (textural elements) were used to determine if the size of the stimulus pattern elements effected preference. Both dark and light hatched chicks were tested for pattern preference.

METHOD

Subjects:

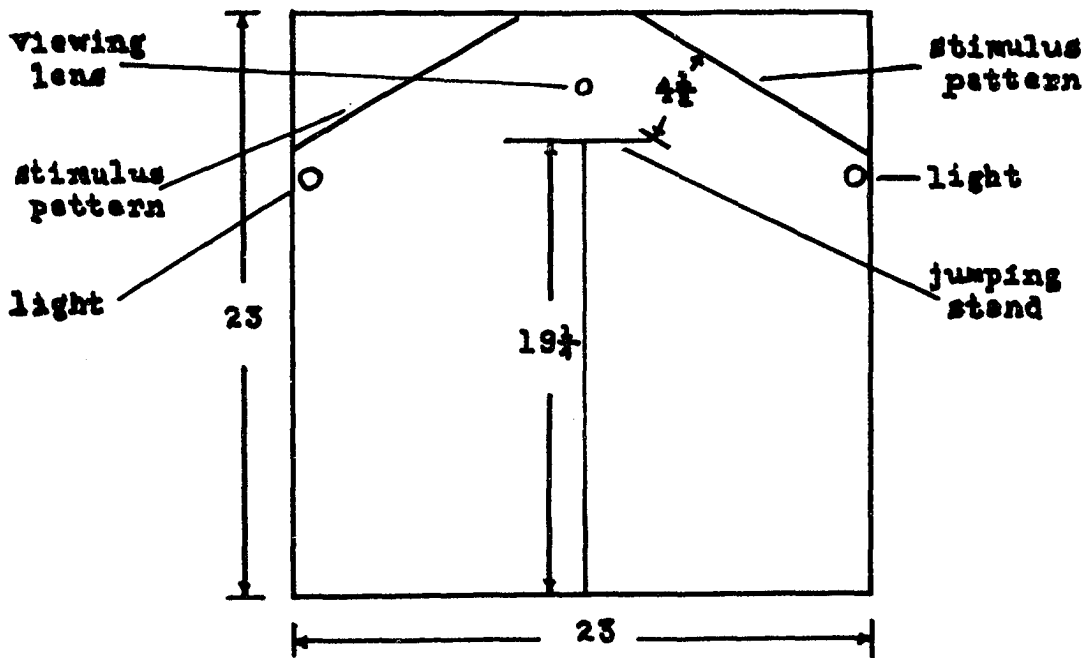
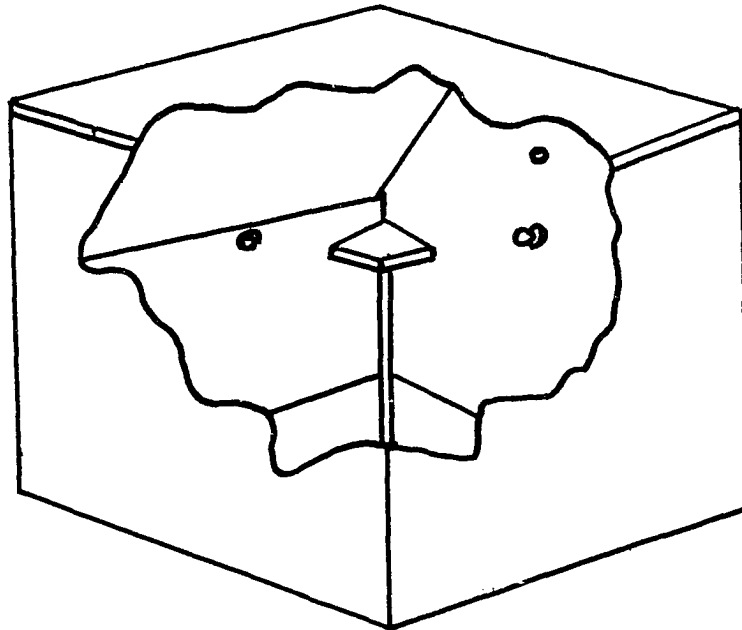
The Ss were 300, 20-hour-old Japanese Quail obtained from the Western Michigan University quail colony. One-half of the Ss were dark hatched and the other half light hatched. The dark hatched group was maintained in egg cartons in a darkened hatcher, except for short exposures, after hatching and before the experimental trial, to a low illuminating red working light. The light hatched group was maintained in a hatcher lighted by an overhead fluorescent light. The quail were contained in small boxes with high sides to prevent their escape. The boxes were open at the top enabling the quail to view the hatcher above them.

An attempt was made to control for early exposure to stimulus patterns similar to those used in the study.

Apparatus:

The apparatus was devised and constructed by Dr. Frank Fatzinger at Western Michigan University (Figure 1). It consisted of a 6 x 6 in. jumping stand placed in the center of an experimental box 23 x 23 x 23 in. The stand was raised to a height of $19\frac{1}{4}$ in. above the base. The top of the box was hinged in such a manner that the Ss could be placed on the stand and removed from the box through the lid.

The inside of the box was flat black; lighting was provided by four, $7\frac{1}{2}$ watt light bulbs placed 6 in. from the top, in the center



Apparatus

Figure 1

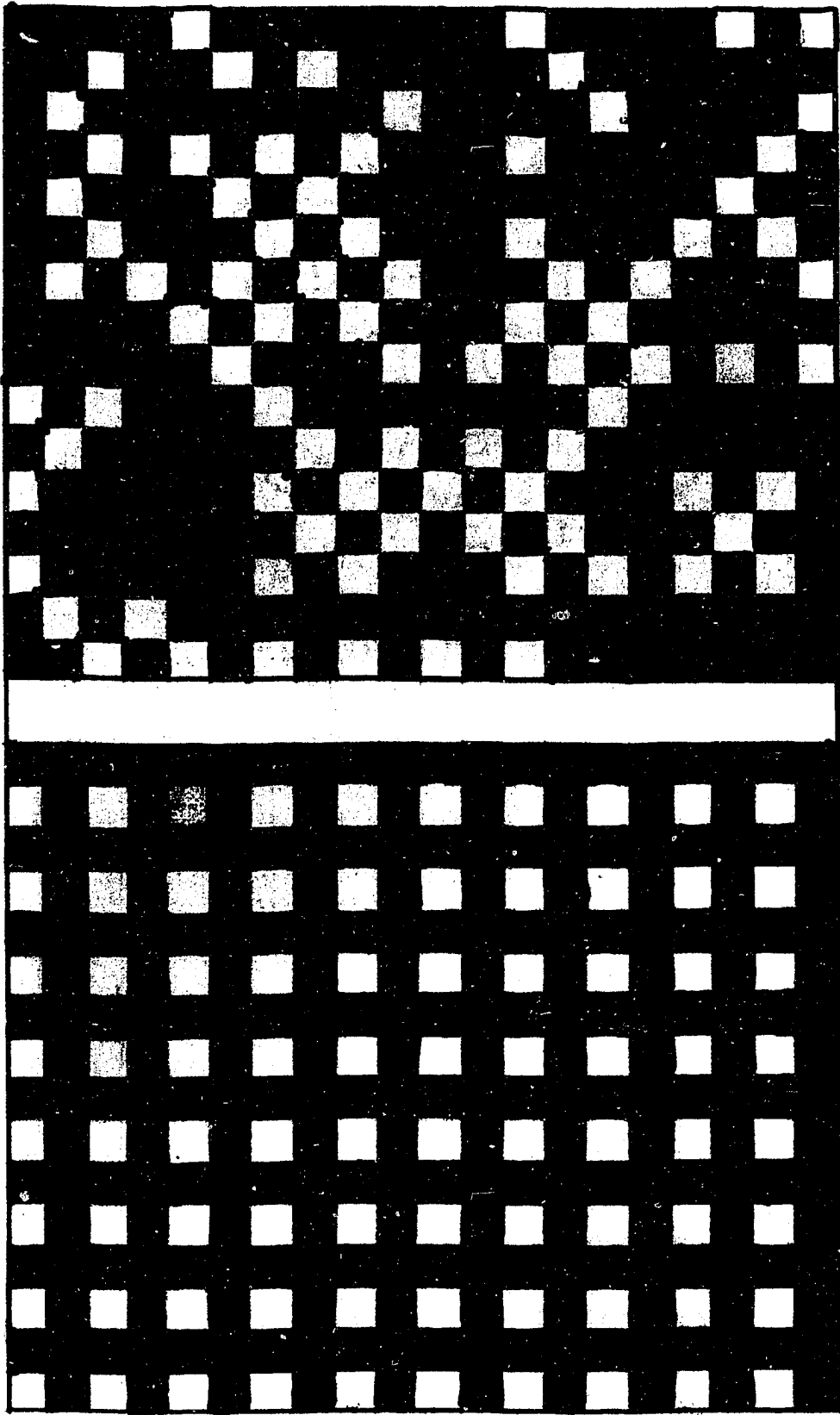
of each of the sides. A small wide angle lens was fixed in the center of the front side to enable E to view the Ss inside the box.

Two opposing stimulus patterns, 10 x 22 in., were attached inside the box forming a gable over the jumping stand. They extended at an angle from a point $9\frac{1}{2}$ in. from the top edge of the box to a point $5\frac{1}{2}$ in. down the side, leaving a space 4 x 22 in. running over the jumping stand not covered by the patterns. The stimulus patterns were held in place by two metal tracks to make them easily interchangeable.

The apparatus was tested and found workable in a previous unpublished study testing stimulus pattern element size preference by Fatzinger.

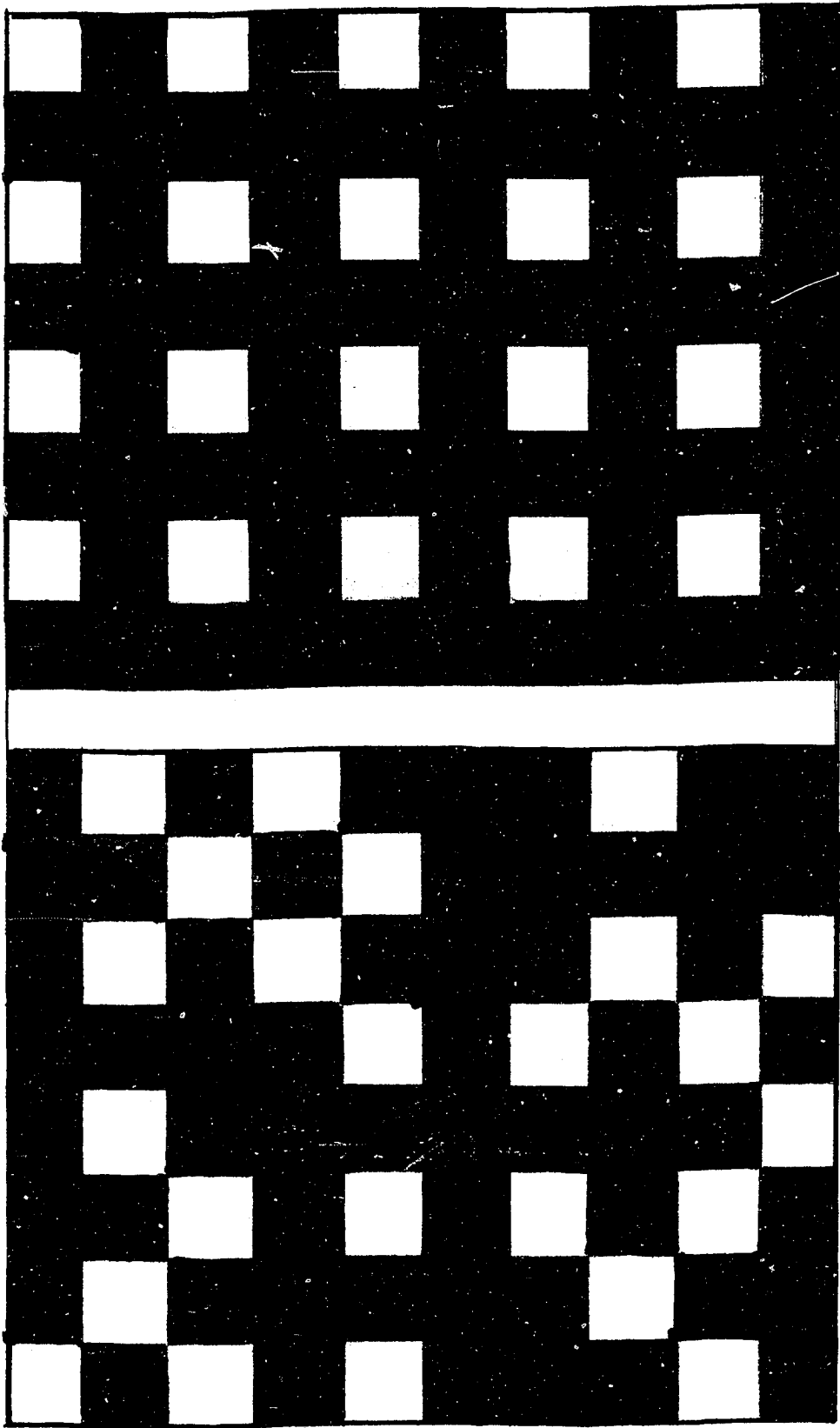
Stimulus Patterns:

Three sets of stimulus patterns, 10 x 22 in., were constructed on black poster board. Each set ($\frac{1}{4}$ in., $\frac{1}{2}$ in., 1 in.) had a regular and a randomized pattern made of white squares (Figures 2,3 and 4). The squares were inked on the poster board using an overlay stencil. Regularly spaced equal distant squares were cut from the stencil totaling 25% of the pattern area. The regular pattern was made by inking all of the squares in the stencil. The random pattern was made by selecting squares to be inked, each having a 50% probability of selection. To keep the number of elements in both patterns the same, it was necessary to stencil the random pattern twice. The second time the pattern was stenciled, the stencil was placed



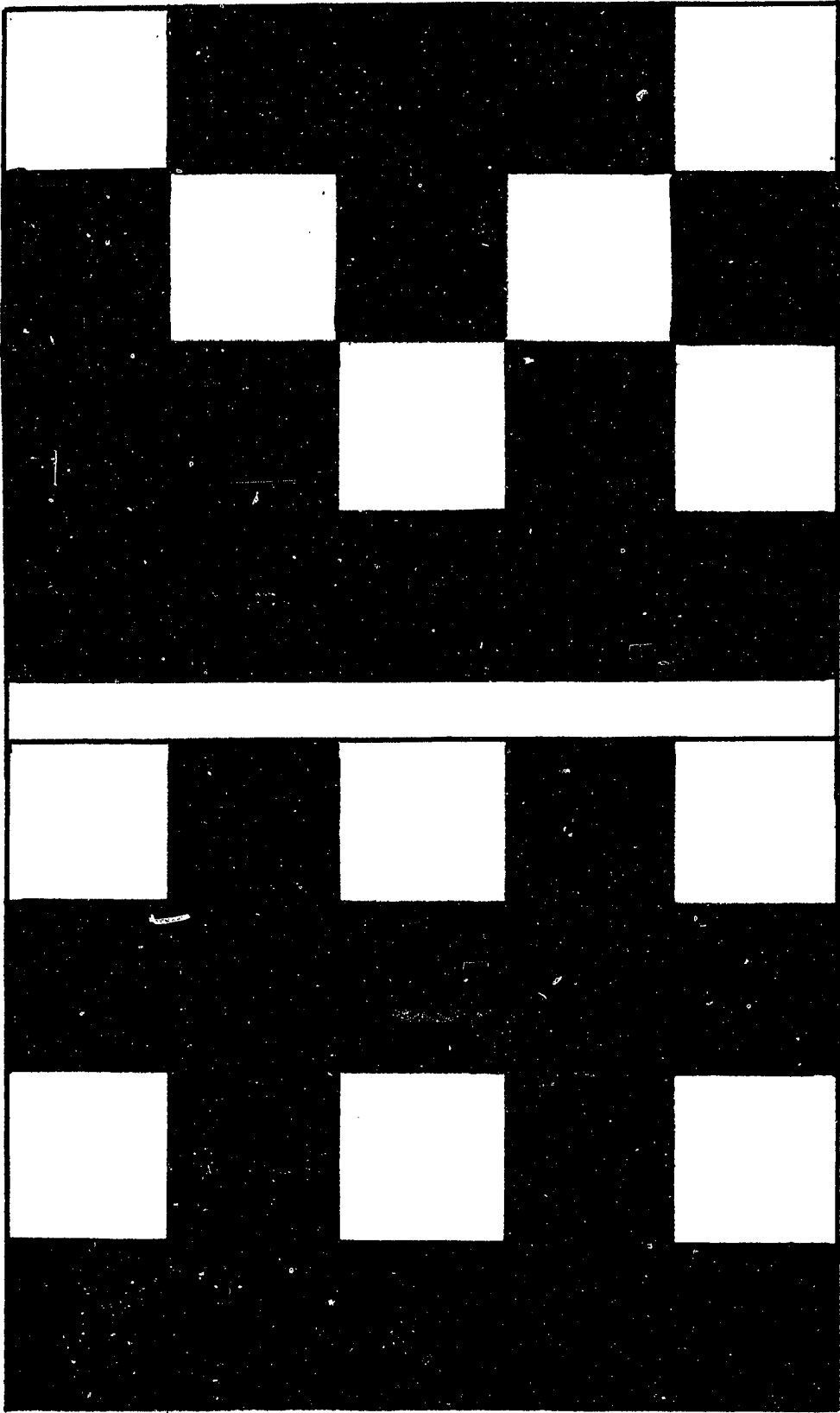
One-quarter Inch Stimulus Pattern

Figure 2



One-half Inch Stimulus Pattern

Figure 3



One Inch Stimulus Pattern

Figure 4

in a position such that none of the squares fell directly adjacent to each other. This kept the contour variable the same in both the random and the regular patterns. The pattern density in all three sets was 25% white space and 75% black space.

Procedure:

The experimental testing procedure was the same for all the Ss in the study. Each S was randomly placed on the jumping stand. The top of the experimental box was lowered and the S was viewed on the stand through the wide angle lens. The S was given three minutes after the top of the box was lowered during which to respond to a pattern. In the few cases in which the S fell from the stand a response was recorded; responses made before and after the appointed time were tabulated separately and not used for analysis.

To control for auditory cues that might influence the response, a masking noise was provided in the background (an air conditioner) and all Ss in the room were kept directly under the experimental box. A low illumination red working light was centered directly above the box. To control for other environmental factors that might influence responses, patterns were shifted every ten trials in an A, B, B, A counterbalance design (A - regular right, random left, B - regular left, random right).

Ss were divided into three dark hatched groups of 50 and three light hatched groups of 50. One light hatched group and one dark hatched group were run on each of the three sets of patterns.

RESULTS

The Japanese Quail used in the study did not show a significant preference for any of the patterns to which they were exposed. The combined groups of 150 light hatched birds responded at a chance level ($\chi^2 = 1.12$, $p > .50$). In each individual group of 50 light hatched quail tested on differently sized pattern elements, the results were also not significant (Table 1). The $\frac{1}{4}$ in. stimulus pattern group responded 28 times to the random pattern and 22 times to the regular pattern. The $\frac{1}{2}$ in. group made 23 random responses and 27 responses to the regular pattern. The third light hatched group, tested with 1 in. stimulus pattern elements, had 26 random responses and 24 regular pattern responses (Table 1).

Tested on the same stimulus patterns, results of the combined groups of dark hatched quail also were not significant ($\chi^2 = 2.32$, $p > .10$). The 50 dark hatched quail tested on the $\frac{1}{4}$ in. stimulus patterns responded 25 times to each pattern. Those tested on the $\frac{1}{2}$ in. patterns made 30 responses to the random pattern and 20 responses to the regular pattern. Twenty-seven random responses and 23 regular responses were made to the 1 in. pattern.

Very little difference was demonstrated in the response of the light and dark hatched quail to the same stimulus patterns. When the light and dark hatched quail were combined for analysis, an interesting trend developed (Table 1). In each of the three pattern size groups, $\frac{1}{4}$ in., $\frac{1}{2}$ in. and 1 in., there were 53 random

Table 1
Frequency of Pattern Responses

Pattern element size	N	Random	Regular	χ^2 Prob.
Light hatched group				
$\frac{1}{4}$ inch	50	28	22	>.30
$\frac{1}{2}$ inch	50	23	27	>.50
1 inch	50	26	24	>.80
Dark hatched group				
$\frac{1}{4}$ inch	50	25	25	1.00
$\frac{1}{2}$ inch	50	30	20	>.10
1 inch	50	27	23	>.50
Combined light and dark hatched groups				
$\frac{1}{4}$ inch	100	53	47	>.30
$\frac{1}{2}$ inch	100	53	47	>.10
1 inch	100	53	47	>.50

pattern responses and 47 regular pattern responses. Analysis of the combined group results according to pattern sizes was also not significant. The $\frac{1}{4}$ in. pattern size had a chi square of $p > .50$, the $\frac{1}{2}$ in. group $p > .20$ and the 1 in. group, $p > .70$.

The response latency time ran generally from 30 to 90 seconds with a maximum permissible time of three minutes. There were 41 inappropriate responses (Table 2) tabulated and not used for analysis. Twenty-three Ss did not respond within the three minute latency time and 18 Ss responded before the appointed time.

Table 2
Frequency of Inappropriate Responses

Pattern element size	N	No response within time limit	Response before appropriate time
Light hatched group			
$\frac{1}{4}$ inch	5	4	1
$\frac{1}{2}$ inch	8	8	0
1 inch	8	7	1
Dark hatched group			
$\frac{1}{4}$ inch	7	1	6
$\frac{1}{2}$ inch	3	1	2
1 inch	10	2	8
All groups	41	23	18

DISCUSSION

When the 300 Japanese Quail in this study were given a choice between two stimulus complexity patterns, with a varying degree of randomness in the placement of pattern elements, no significant preference was noted. These results, in part, support the findings of Karmel (1966). He determined that both rats and chicks preferred less random patterns. The problem he noted in his study was that randomness and contour, both elements of complexity, seemed to be confounded. In the present study the contour variable was more closely controlled by decreasing the density of stimulus pattern elements. This enabled the number of light-dark transitions, in opposing patterns, to be kept exactly the same. The failure to achieve a significant difference in response to the patterns used in this study might indicate that Karmel's chicks were responding to stimulus pattern and/or textural element size. Some support for these conclusions can be substantiated by Berlyne (1958) and Herschenson (1964). In his work with human infants Berlyne concluded that the complexity patterns preferred were ones with more contour. Berlyne (1960) incorporated randomness into his operational definition of stimulus complexity, but discussed it in terms of dissimilarity between individual stimulus pattern elements. In the present study the elements were exactly the same, and randomness was defined as the placement of the elements on the stimulus patterns.

A second important aspect of the stimulus patterns used in the research was the size of their elements. In work with Japanese Quail, Fatzinger noted a preference for elements of greater size. Walk and Gibson (1961) reported that chicks established preference for textures with smaller elements. Karmel (1966) found that element size seemed to correlate with pattern choice when he found that both chicks and rats preferred textures with smaller element size. In the present research the textural element size remained exactly the same in the opposing stimulus patterns, although differently sized elements were used on the three sets of patterns. The fact that a preference was not established may in part have resulted from the absence of element size difference in opposing patterns. Preference for pattern size could not be established through response latency times because such data was not collected.

Little difference was determined in the response of light and dark hatched quail to the stimulus patterns. The most notable difference was in inappropriate responses (Table 2). The light hatched quail showed a greater tendency to remain on the jumping stand longer than the three minute limit, while the dark hatched group more often demonstrated the inappropriate response of leaving the stand too early. This response difference may be accounted for by the fact that the dark hatched birds were placed in the experimental box on their first exposure to bright light, given little chance for visual stimulation. The light hatched birds, on

the other hand, were maintained under lighted conditions and given the opportunity for visual stimulation before the experimental trials.

The height of the jumping stand and the overhead placement of the stimulus patterns were the two points at which the basic experimental design of this research differed from that of Karmel (1966). It might be suggested that the height of the jumping stand had a confounding influence on the results. Although the height was the same for responding to either of the patterns, the effects of height (Walk and Gibson, 1961) could have taken precedence over that of the stimulus patterns. The results would then reflect the effects of the height of the jumping stand on the quail. Reviewing the data, twenty-three out of the total 341 Ss in the study failed to respond within the three minute time limit. The response latency demonstrated here seems to indicate that the Ss readily jumped from the stand. Thus it might be indicated that the effects of height of the stand played a minor role in the results.

The results presented here seem to indicate that stimulus complexity, defined in terms of the more random placement of like elements on a stimulus pattern, is not preferred by Japanese Quail in the context of the present experimental situation. Further work, with randomness as an element of complexity, is indicated by the results. Special attention should be given, in stimulus pattern construction, to incorporate dissimilarity in individual textural

elements as well as random placement of elements.

SUMMARY

Three hundred twenty-hour-old Japanese Quail were tested on stimulus complexity patterns ($\frac{1}{4}$, $\frac{1}{2}$, 1 inch element sizes) with a varying degree of randomness in the placement of individual textural pattern elements. Both light and dark hatched quail, tested on a jumping stand with opposing overhead patterns, demonstrated no significant preference for any of the patterns presented. It was concluded that a greater degree of randomness was not preferred by the quail.

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