10-1969

Stimulus Balance and Preference in the Japanese Quail

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STIMULUS BALANCE AND PREFERENCE IN THE JAPANESE QUAIL

by

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A Thesis submitted to the
Faculty of the School of Graduate
Studies in partial fulfillment
of the
Degree of Master of Arts

Western Michigan University
Kalamazoo, Michigan
October 1969

ACKNOWLEDGMENTS

The writer wishes to express his sincere appreciation to the many persons who contributed to this research. I would especially like to thank Dr. Frank Fatzinger, my thesis advisor, for his invaluable advice and counsel. I also appreciate the help given me by the members of my thesis committee, Dr. Paul T. Mountjoy and Dr. Chris Koronakos. Final thanks goes to my wife Beverly for typing the manuscript.

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MASTER'S THESIS M-2164

MEAD, Richard Leon
STIMULUS BALANCE AND PREFERENCE IN THE JAPANESE QUAIL.

Western Michigan University, M.A., 1969
Psychology, general

University Microfilms, A XEROX Company, Ann Arbor, Michigan

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INTRODUCTION

Gibson (1966), in discussing the orientation of an organism to its environment, refers to the concept of rheotropism. An organism responding rheotropically tends to orient itself by positioning its bilateral receptors in relation to a flow of air or water. Rheotropism is a type of orienting response which belongs to the tropotaxis classification (Hinde, 1966).

The essential features of tropotaxis consist of a simultaneous comparison of stimulus intensities by bilateral receptors with a resulting orientation that achieves and maintains a balance of receptor inputs. Such a balance would be obtained only when the center of the stimulus source lies in a plane which bisects the organism equilaterally (Fraenkel, 1961).

This type of orientation is said to utilize a neural servomechanism. Within this neural control mechanism, stimulus information is processed and automatic compensating responses are made by the organism to achieve a balanced stimulus input condition (Gibson, 1966; Hinde, 1966).

One method of research which has been used to study tropotaxis involves the comparison of the behavior of organisms which have been unilaterally blinded with the behavior of those which have not. Positively phototropic organisms, such as the crustacean Armadillium, are exposed to a visual stimulus consisting of either a single or a double light source. Characteristically, unblinded organisms tend to move in a direction toward the single light or between the double lights. Unilaterally blinded animals tend to follow curved paths called circus movements in a direction away from the blinded side. It is hypothesized that this is an attempt by the tropotactic neural mechanism to increase the stimulus input to the blinded side to equal that of the unblinded side (Gibson, 1966; Hinde, 1966).

Prior unpublished research by the author was conducted to test the hypothesis that naive Japanese quail would respond tropotactically to a preferred visual stimulus field by orienting to the center of the field. The results of this research indicated that the quail preferred the black field rather than the white field and that they oriented themselves toward the center of the black field as predicted. Although these findings supported the hypothesis, further research is needed. The preference of the quail for the darker stimulus field should also be further investigated. It is suggested that the aversive nature of the high stimulus level of the white field to the visually naive quail tended to result in the preference for the lower stimulus level black field as an avoidance response.

The purpose of the present study is threefold. First, it will serve as an attempt to replicate the previous work done by the author. Second, it will further examine the center field preference response of the quail by determining the influence that unilateral blinding will have on this response. It is hypothesized that unilateral blinding will tend to result in a shift of the characteristic center field preference to one side or the other of center. If it can be demonstrated that these organisms do respond tropotactically, the fact that they are visually naive would lend support to the unlearned nature of this response system. Third, the preference for the black field will be examined by systematically lowering the stimulus field illumination level. It is hypothesized that at lower illumination levels the white field will be less aversive and result in a decreased preference for the black field.

Basic to the purpose of this study is the unlearned quality of the orienting response of the organism. To preserve this quality it is necessary that the subjects chosen for testing will have had minimal visual and behavioral experience. Therefore the subjects will be reared in the dark prior to testing and given no opportunity to make a response similar to the one required during testing. Each subject will be used only once to eliminate the influence of any learning which could occur during the testing procedure.

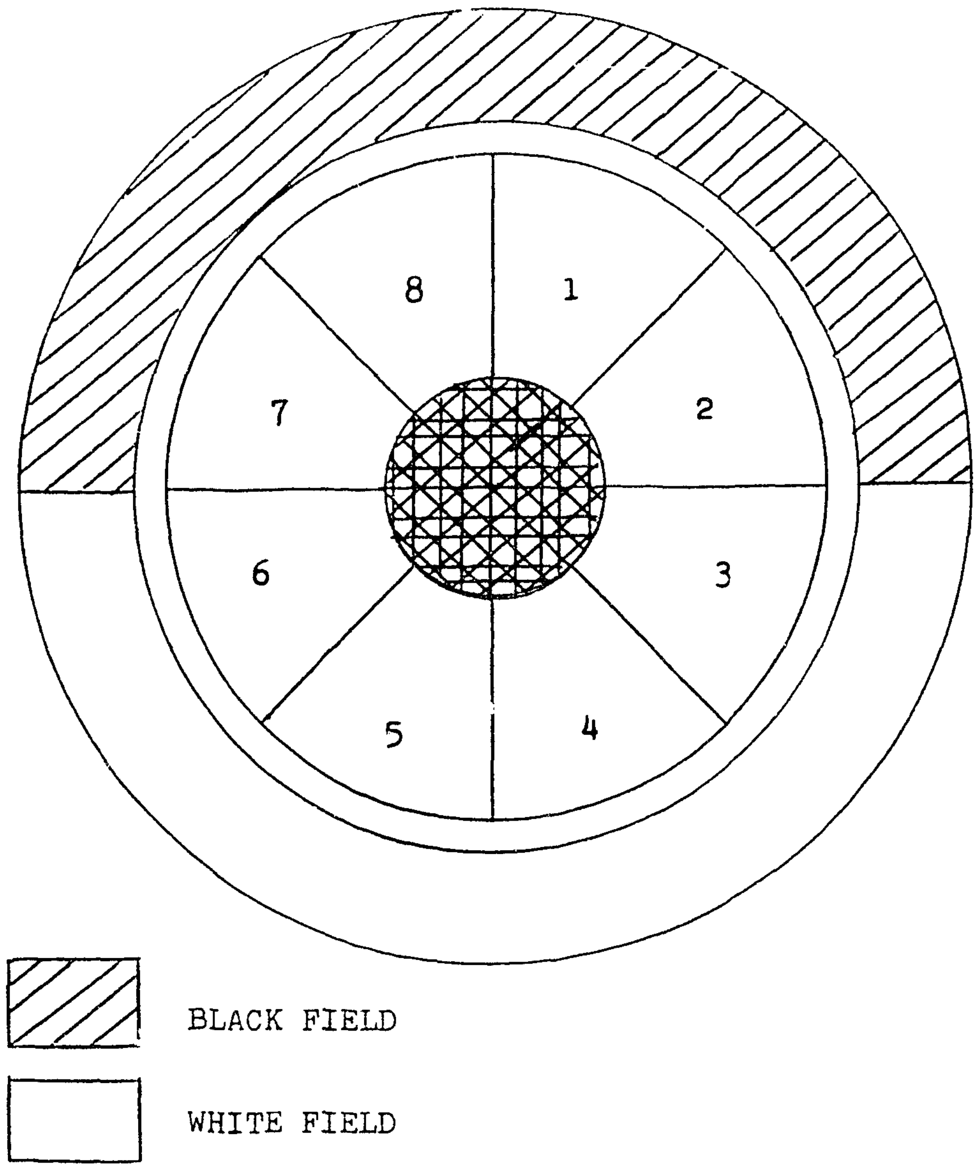
METHOD

Subjects

Subjects for this study were 611 Japanese quail (*Coturnix coturnix japonica*) who were between 16 and 20 hours old. These quail were visually naive having been hatched and reared under conditions of minimum exposure to light prior to testing. Five groups of quail were used for testing.

Apparatus

The apparatus consisted of a 5 inch diameter round jumping platform which was 10 inches high and placed in the center of a 14 inch diameter vertical cylinder which had a total overall vertical height of 18 inches. A 180° segment of the internal circumference of the cylinder was painted flat white, and the other 180° segment was painted flat black. The bottom of the cylinder was divided by 2 inch high partitions into eight 45° pie-shaped segments and painted flat black. Four of these segments were below the black portion of the inner cylinder surface and four were below the white portion. (See Figure 1 for a graphic representation of the segment and stimulus field relationship.) The top of the



Center Black Area	Segments #1 & #8
Edge " "	" #2 & #7
Center White "	" #4 & #5
Edge " "	" #3 & #6

Fig. 1 Stimulus field and jumping segment pattern.

cylinder was painted black and had an 8 inch diameter access hole which was covered during testing.

Illumination of the internal surface of the cylinder, which constituted the stimulus fields, was provided by a standard incandescent lamp located directly below the jumping platform. The illumination level of the black and white fields was varied by using bulbs of varying wattages. For the four conditions under which this test was run, bulbs of 60, 40, 15 and 7½ watts were used. The light reflected from the two fields when illuminated by each of these four bulbs is given in Table 1. Light levels were measured with a General Electric c/c (Color and Cosine Corrected) Light Meter. Readings were taken of the light reflected from the fields with the meter placed on the center of the jumping platform. The ratio of the reflected light from the black and white fields was approximately 1:10 for all illumination levels.

Procedure

After hatching, the quail were taken from the incubator and placed in chicken egg cartons with approximately fifteen chicks per carton. These cartons were stored for 16 hours in a darkened incubator until the birds were ready to be tested. About 5

Illumination Bulb Wattage	Foot Candles White Field	Foot Candles Black Field
$7\frac{1}{2}$	2.	.25
15	5.	.5
40	24.	2.
60	51.	5.

Table 1. Illumination lamp wattage and stimulus field light intensity.

minutes prior to testing the birds were taken from the egg cartons and placed in a heated and ventilated holding box until testing. The general procedure was to take each subject from the holding box and place it on the jumping platform in a random orientation. After the subject was placed on the platform, a cover was placed over the access opening. The subjects were observed through a ½" diameter peephole in the upper corner of the cylinder. A jump was considered to be valid if it occurred after the cover had been placed over the access opening and before an interval of two minutes had elapsed after the cover was in place. The jump was recorded according to which numbered segment the bird fell into at the bottom of the cylinder. The subject was then removed from the apparatus and discarded. The testing for each group was terminated when 100 valid jumps had been obtained.

Group #1 was tested with the stimulus field illumination provided by a 60 watt bulb. This group replicated the previous experiment done by the author. Groups #2, #3 and #4 were tested with 40, 15 and 7½ watt bulbs respectively. These three groups were tested to investigate the influence of varying levels of illumination.

Group #5 was tested with a 60 watt bulb illuminating the fields. In this group the subjects were unilaterally blinded by placing a 3/8 inch square piece of black opaque Scotch electrical tape over the right eye. This tape adhered to the feathers surrounding the eye and served as a simple but efficient way of preventing light from reaching the eye.

The jumping responses of all subjects were recorded according to the position of the segment into which each landed. Segments were categorized according to their relationship to the two stimulus fields. The categorization provided for equal probability of center or edge responses if the jumping behavior was not being controlled by the stimulus fields.

Because the 60 watt bulb had been used for illumination in the previous study by the author, Group #1 which uses the same bulb was used as a control group. The results obtained from Group #1 were compared to those in the previous study and the results of manipulations in this study.

RESULTS

The four categories of jumping responses used to analyze the obtained data were Black Center, Black Edge, White Center and White Edge (See Figure 1). The results of this tabulation of the data is shown in Table 2.

Chi-square analysis of the data from Group #1 indicated that the black field preference was significantly greater than that of the white field, ($X^2 = 13.8$, $df = 1$, $p < .01$) and that the field center over field edge preference was also significant ($X^2 = 25$, $df = 1$, $p < .01$).

To determine the suitability of this study as a replication of the previous one done by the author, the data from Group #1 were compared with the data of the previous study (See Table 3). Analysis indicated that the differences between the two groups were not significant ($X^2 = 7.6$, $df = 3$, $p > .05$). It is concluded that there is no significant difference between the two groups, and that this portion of the present study did replicate the previous study.

The influence of unilateral blinding upon the characteristic field center preference (see above)

Group	Black Center	Black Edge	White Center	White Edge	Total
#1 60 Watt Illumination	57	12	18	13	100
#2 40 Watt Illumination	42	21	21	16	100
#3 15 Watt Illumination	45	20	22	13	100
#4 7½ Watt Illumination	58	16	20	6	100
#5 60 Watt Unilaterally Blinded	46	29	11	14	100
Total	248	98	92	62	500

Table 2. Jumping behavior for all groups.

	Previous Study Group	Present Study Group #1	Total
Black Center	53	57	110
Black Edge	23	12	35
White Center	14	18	32
White Edge	4	13	17
Total	96	100	196

$X^2 = 7.6$, $df = 3$, $p > .05$

Table 3. Jumping behavior comparison for previous study and Group #1 of present study.

	Group #1 60 watt Illumination	Group #5 60 watt Illumination	Total
Black Center	57	46	103
Black Edge	12	29	61
White Center	18	11	29
White Edge	13	4	17
Total	100	100	200

$X^2 = 9.9$, $df = 3$, $p < .05$

Table 4. Jumping behaviors of Groups #1 and #5.

was investigated by comparing the responses of Group #1 with Group #5. For both groups a 60 watt bulb was used for stimulus field illumination. Group #1 was not blinded and Group #5 was blinded in the right eye. Inspection of Table 4 indicates that unilateral blinding had the effect of reducing the preference for the center of the stimulus fields. Chi-square analysis of the responses for these two groups indicates that the differences between them are significant ($X^2=9.9$, $df=3$, $p<.05$). Analysis of the field center and field edge responses of the unilaterally blinded group indicates that the center field preference is still significant ($X^2=6.4$, $df=1$, $p<.05$), but it is less than that of the unblinded group ($X^2=25$, $df=1$, $p<.01$). It is concluded that unilateral blinding is related to a decreased tendency for the subjects to orient themselves centrally on a stimulus object.

Unilateral blinding then has the effect of reducing the tendency to jump to the center of the stimulus field, but this tendency, though reduced, is still significant. The original hypothesis which would have predicted a significant shift from the center jumping pattern to one side or the other was not supported.

To see if a reduction of stimulus intensity would result in a reduction in the preference for the black stimulus field, the results of testing Groups 1, 2, 3 and 4 were compared (See Table 5). Chi-square analysis of these data showed that there was no significant difference between the responses of these four groups ($X^2=10.3$, $df=9$, $p>.10$). It is concluded that variations in absolute stimulus field intensity levels do not influence the preference for the dark field.

Group	Black Center	Black Edge	White Center	White Edge	Total
#1 60 Watt Illumination	57	12	18	13	100
#2 40 Watt Illumination	42	21	21	16	100
#3 15 Watt Illumination	45	20	22	13	100
#4 7½ Watt Illumination	58	16	20	6	100
Total	202	69	81	48	400

$X^2 = 10.3$, $df = 9$, $p > .10$

Table 5. Jumping preference of Groups #1-4.

DISCUSSION

The analysis of the data from a portion of this study indicates that the previous study done by the author was successfully replicated. The replication group was statistically similar to the previous study and also showed a significant black field and black field center preference.

The portion of the study which investigated the influence of unilateral blinding indicated that this manipulation did not result in the predicted shift of the center preference jumping response. The lower level of the tendency to jump to the center indicates that this organism while still able to orient toward a preferred stimulus object, is not as efficient as it would be with binocular vision. It is suggested that further investigation of this area could be conducted utilizing the two light experimental technique which has been used with other organisms (Fraenkel, 1966; Hinde, 1966). In this situation a tropotactic organism tends to go between two lights of equal intensity when they are placed in its field of vision.

The results of this study did not support the hypothesis that the black field preference was due to the aversive nature of the higher stimulus level white field to a dark reared organism. There was no significant changes in the jumping behavior as the stimulus illumination level was decreased. It is possible that had the level been pushed lower some changes would have been observed, but it would seem that the range of illumination intensities employed in this study would have resulted in at least the indication of some change if aversiveness was a major variable. It is suggested that further study in this area could investigate the effect of varying the ratio of the stimulus levels of the two fields.

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