THE EFFECTS OF CONSPECIFIC VOCALIZATIONS AND REPEATED TESTING ON THE DURATION OF TONIC IMMOBILITY IN BOBWHITE QUAIL (COLINUS VIRGINIANUS)

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ABSTRACT

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by

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Ratner (1967) has proposed that tonic immobility (animal hypnosis) is a response by prey to the predator. Stoddard (1931) has stated that the covey call and the alarm note of the Bobwhite quail are sounded in the context of predator defense: Alarm note to alert the other quail in the area, and Covey call to signal the absence of a predator. The purpose of this study was three-fold. First, to assess the adequacy of adult Bobwhite quail as good preparations for the study of tonic immobility. Second, to determine the effects of the alarm note and covey call on the duration of tonic immobility. Third, to determine the extent to which the immobility response can be habituated in these birds.

Due to the long durations of immobility and their great individual differences, the adult Bobwhite was not

an ideal preparation for the study of tonic immobility. Duration measures, however, proved to be reliable for individual subjects.

While no main effects were significant, a three-way analysis of variance found two interactions in which the linear component was significant. The Conditions by Trials interaction revealed that both the covey call and a neutral tone decreased durations over trials. Two tentative explanations of this result are offered. The Sex by Trials interaction showed that durations for males decreased over time. This sex difference was noted but not explained.

Eight subjects from the total N of 32 were subjected to two post-tests. In one, the procedure of the study was continued for seven additional trials. The other involved handling the subjects. In none of the testing used in this study was there evidence of habituation of the tonic immobility response.

Stanley C. Ratner, Professor,
Psychology
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This thesis is dedicated to my wife, Karen, and to my daughter Kristin.

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INTRODUCTION

The tonic immobility response is a well documented behavior exhibited by a wide variety of species. In vertebrates, it is characterized by prolonged immobility, an apparent lack of responsiveness to external stimulation, and a tonic posture (Figure 1).

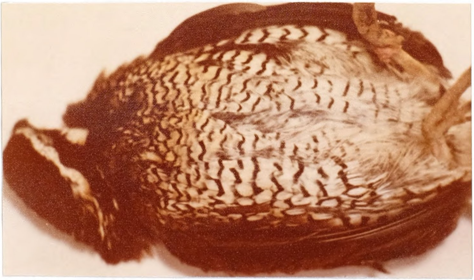

Figure 1. A male Bobwhite quail in tonic immobility.

Ratner (1967) has provided one of the most complete reviews of research on this phenomenon. His review suggests that tonic immobility is a response by the prey to a predator, and that restraint by a novel stimulus (the predator) is necessary to elicit the immobility response. Existing evidence indicates that immobility may function to reduce the probability of attack when no other means of escape is available (Armstrong, 1965).

One characteristic of tonic immobility is the lack of response by the animal to external stimulation. Prodding the animal, applying electric shock, cutting, or pricking the animal with a pin do not terminate immobility in many instances (Ratner, 1967). Other evidence, however, suggests that immobile animals may be receptive to external stimulation. Klemm (1966) detected changes in EEG patterns of immobile rabbits when he presented them with a sudden loud noise, although the animals remained immobile. Ratner (1958) found it was possible to terminate immobility in rabbits with a sudden noise. Ratner (1967) also noted a dramatic increase in heart rate of immobile adult pigeons in response to a loud noise. Doty (1969) has shown that a visually demanding stimulus (a revolving nystagmus drum) significantly reduced the duration of immobility in adult Bobwhite quail. Liberson (1948) demonstrated that visual, auditory, and tactile stimulation were capable of terminating the immobility response in guinea pigs. The question of receptivity to external stimulation by animals in tonic immobility has clearly not been resolved.

Another characteristic of immobility is that repeated testing with spaced trials has been shown to reduce the duration of immobility in adult domestic chickens (Gilman, et al., 1950). Exposure over several days to the experimenters was also sufficient to reduce the duration of immobility in domestic chicks (Ratner and Thompson, 1960). Taming the animals apparently reduced

the novelty of the experimenter as a stimulus. Ratner (1967) noted that laboratory rats must not have a history of handling by the experimenter if immobility is to be elicited. Habituation has been defined as "the relatively persistent waning of a response to certain stimuli" (Denny and Ratner, 1970, p. 519). To separate taming effects from habituation of immobility is difficult. (Taming changes the stimulus charactics of the experimenter by reducing his novelty. Habituation is the waning of a response to repeated presentations of the same stimulus.) If contact with the experimenter were minimized (limited to test trials, for example), changes in the duration of immobility after repeated testing could be considered as evidence in favor of habituation rather than taming.

Ratner (1967) reported that birds are especially good preparations for the study of the immobility response. The Bobwhite quail (Colinus virginianus) is a comparatively new laboratory animal. It is not yet, therefore, domesticated to the extent of chickens, laboratory rats, and pigeons. If tonic immobility is an innate response to predators, as we believe, it might appear more strongly in the Bobwhite quail than in domestic species of birds. A study by Doty (1969) suggested that adult Bobwhite quail immobilize readily, but he used only a few subjects. Borchelt (1970) reported the development of both freezing and immobility in immature Bobwhite quail. Only these two experiments studied the immobility response in Bobwhite quail. It has not been confirmed, therefore, that

adult Bobwhite quail are good immobilizers.

Bobwhite quail rely on vocalizations in the context of predator defense. The alarm note serves to alert other quail to the presence of a predator and to maintain freezing behavior (Stoddard, 1931). Stoddard (1931) also reported that the covey call functions to re-group the members of a quail covey when the predator has departed the area. The alarm note, therefore, is sounded in a "fearful" situation, while the covey call is sounded in a safe, "non-fear" context. It might be expected, therefore, that the alarm note and covey call would affect the duration of tonic immobility differentially.

Statement of Problem

This study is designed to obtain information relating to three questions. First, are adult Bobwhite quail a good preparation for the study of tonic immobility? This can be determined by using a reasonably large sample of birds. Second, will two conspecific vocalizations, the alarm note and the covey call, differentially affect the duration of tonic immobility? If so, this would be evidence for the role of tonic immobility in predator defense, and indirectly for the role of "fear" in producing tonic immobility. It would also suggest that Bobwhite are receptive to auditory stimulation during immobility. Third, will minimization of contact with the experimenter and repeated, spaced trials reduce the duration of immobility over trials, providing evidence that the immobility response can be habituated in Bobwhite quail?

METHOD

Subjects

Thirty-two quail (*Colinus virginianus*) were obtained from the Michigan State University Poultry Science quail colony. The birds were approximately three years of age at the time of the study. The quail had been hatched, brooded and raised in the colony. Housing facilities in the colony were Petersime brooder cages, and 30 to 50 birds were housed in each cage. The quail obtained from the colony were selected for comparatively healthy plumage and clear eyes (corneal cataracts sometimes develop in quail of this age). Seven days before each session of the experiment, birds were transported from the colony to the lab and banded with colored, soft plastic leg bands. The birds were then placed in the experimental apparatus where they were maintained on *ad lib* water and food (Michigan State University Quail Breeder, King Milling Company) under a 14:10 light:dark cycle.

Apparatus

Figure 2 is a photograph of the housing-testing apparatus in which the birds lived during the experiment. The wooden boxes (92 cm. long, 61 cm. wide, and 46 cm. deep) radiating from the center area were detachable and could be moved to another room where they served as

testing chambers. The rear of each box was an enclosed chamber (46 cm. long, 61 cm. wide, and 23 cm. high) which contained straw. The tops of these enclosures were hinged.

Figure 2. The housing-testing apparatus.

The Ss were allowed free access to the "cover" chambers which represented, it was hoped, a simulation of natural cover. Fiber-board partitions could be inserted to isolate an S and allow detachment of a testing box. The entire apparatus was covered with removable sections of quarter inch mesh hardware cloth. The floor was covered with 2 cm. of sand. A platform mounted on casters was used to transport the testing chamber containing an S to the testing room. The testing room measured 4½ m. by 6½ m. and was illuminated by overhead incandescent lights. Empty rat colony cages were stored in one corner of the room. The testing room was located approximately 15 m. from the colony room.

The vocalizations were recorded on continuous loops of Scotch magnetic tape. A Wollensack tape recorder

was used to present the recordings. Durations were timed with a stop watch. Blue light was provided by a 15 watt General Electric warm white incandescent bulb 45 cm. long which was covered with dark blue plastic. The blue light produced was a straight wide band ranging from 427-534 nm as measured by a Gaertner L231 wavelength spectrometer. Many birds are insensitive to blue light (Sturkie, 1965, p. 416), and preliminary investigations had suggested this to be true for Bobwhite quail.

Procedure

The experiment was conducted during the months of February, March, and April in 1970. The average temperature was 26.7°C in the colony room and 24.5° C in the testing room. The experiment consisted of an initial study and two post-tests. The present study used four sets of subjects. The subjects in the first set, one male and two females, were tested over six days with one trial per day for each S. These three Ss were then removed and the second set of Ss (four males and four females) were housed in the apparatus for seven days before testing was resumed. Set three contained ten birds (five males, five females), and eleven birds (six males, five females) were included in set four. From each set, Ss were randomly assigned to the following conditions (sex was balanced within the four conditions over the total of thirty-two subjects).

Condition I. The covey call, recorded from a commercial record, at 72 dbs.

Condition II. The alarm note, recorded in our laboratory, at 70 dbs.

Condition III. A pure tone equalling the mean frequency and duration of the covey call and alarm note as calculated using spectrographic analysis (2000 Hz, 2½ sec.). This was also recorded in our laboratory and was presented at 70 dbs.

Condition IV. A blank tape loop to control for tape recorder noise.

The continuous tape loops were 10 sec long, with one presentation of the stimulus during each revolution. Sound levels were measured with a General Radio 15550 Sound Survey meter on a DBA weighted scale. Measurements were taken in the test lab which was an accoustically live, hard surfaced room. The meter was placed in the testing chamber which was 1 m. from the tape recorder.

Data were pooled from the four sets of subjects, producing and N of eight in each of the four conditions.

The following testing procedure was used each day.

1. E entered the colony room and turned off the overhead lights.
2. Using an L-shaped prod, the E gently herded all of the birds into the center section of the apparatus while he partitioned off the test boxes and cover chambers. This was performed under blue light. The birds were quiet under blue light.
3. One box was removed for use as a holding chamber.

The Ss were then left undisturbed for 10 minutes.

4. E re-entered the colony room, raised the test chamber partition, and gently herded one S into the testing chamber using the L-shaped prod. Again, blue light was used.
5. Turning out the blue light, the E placed the testing chamber on the platform and rolled it down a lighted hall to the illuminated testing lab. The E made an effort to remain out of view of the S while transporting it to the lab, and the Ss typically remained quiet.
6. The bird was identified by its leg band, and the appropriate tape loop was placed on the recorder. The recorder was turned on (this produced a small click) but the volume remained at zero.
7. Approximately 60 seconds after the bird was identified, the E moved the wire top of the box ajar, captured the bird, and removed the partition to the cover chamber.
8. E elicited the immobility response by holding the bird on its back with wings held to its sides (Figure 3). Only enough pressure was applied to hold the bird so it could not move for 30 sec. E then released the bird.
9. The E turned up the volume control on the recorder, quietly retired from the room, and observed the S through a small aperature.

Figure 3. Induction of the tonic immobility response.

10. Tonic immobility terminated when the S got to its feet. This followed the commonly accepted definition of the duration of tonic immobility (e.g. Bayard, 1957; Doty, 1969; Hoagland, 1928; Mowrer, 1932; Liberson, 1948; Liberson, Smith, and Stern, 1961; Ratner, 1958; Ratner and Thompson, 1960). A limit of 6000 seconds of immobility was set for practical purposes. A criterion of at least 40 seconds of immobility was also required. If not met, induction was repeated. Thus, at least one presentation of the auditory stimulus occurred within each duration recorded.

11. Upon termination of immobility, E re-entered the testing room, turned off the recorder, and replaced the partition to the cover chamber. The testing box was returned to the darkened colony room, and the S was herded into the holding box.

12. The test box was positioned, another bird was isolated in it, and the procedure was repeated. After the last bird was tested, the Ss remained in the holding box an additional 10 minutes before being returned to the housing-testing apparatus. During this time water and food were replenished under blue light. The colony room was then illuminated.
13. This procedure was repeated on five consecutive days for a total of six trials for each S.

Two post-tests were conducted to examine habituation of the immobility response. Three Ss were randomly discarded from Set Four, with the restriction that the sexes were equally represented in each condition. The remaining Ss (one male and one female in each of four conditions) were tested using the above procedure for an additional seven trials.

The second post-test used the same eight Ss. Two males and two females were randomly selected and given 40 trials of handling in the test box approximately 24 hours after the thirteenth trial. Handling consisted of picking up and stroking each bird for 30 seconds. All four birds were in the test box during handling so that each S was exposed to the E for two minutes during a trial. The E left the birds in the test box and retired from the testing room for three minutes between trials. At the conclusion of the 40 handling trials, the birds were returned to the hausing apparatus. All eight Ss were tested on trial fourteen after 24 hours had elapsed.

RESULTS

The results will be presented in four sections. In the first section, the results considering the effects of conspecific vocalizations on the duration of immobility will be presented. The second section will examine sex differences in duration of immobility. The third section will consist of an examination of the data for evidence of habituation of the immobility response. Finally, the reliability of the duration scores for individual birds will be tested in the fourth section.

Durations of immobility ranged from 45 to 6000 seconds. Five trials were artificially terminated at 6000 seconds for one bird. The data, therefore, were skewed and heterogeneous. To be able to use parametric statistics, the data were transformed to approximate homogeneity. The square-root transformation was the minimal transformation necessary to approximate homogeneous data as determined by the F-max test. The transformed duration scores were then treated with a three-way analysis of variance. The linear components of two interactions were significant (Table 1).

Effect of Conspecific Vocalizations

Although none of the main effects were shown to be significant by the analysis of variance, the Conditions by Trials interaction was significant ($F=4.18$, $df=7$, $p<.05$).

Table 1. Three-Way Analysis of Variance (Conditions, Sex, Trials).

Source of variance	df	SS	MS	F
Conditions	3	3,520.24	1,173.41	1.176
Sex	1	181.06	181.06	< 1
C X S	3	1,468.43	489.48	< 1
S (C X S)	24	23,940.35	997.52	< 1
Trials	(5)	1,090.81	218.16	1.32
linear	1	601.70	601.70	2.23
quadratic	1	13.92	13.92	< 1
other	3	475.20	158.40	1.18
C X T	(15)	6,219.39	414.63	2.51**
linear	3	3,382.09	1,127.36	4.18*
quadratic	3	661.52	220.51	1.41
other	9	2,175.79	241.75	1.81
S X T	(5)	2,272.89	454.58	2.75*
linear	1	1,182.12	1,182.12	4.39*
quadratic	1	367.68	367.68	2.35
other	3	723.09	241.03	1.80
C X S X T	(15)	3,201.24	213.42	1.29
linear	3	262.20	87.40	< 1
quadratic	3	51.16	17.05	< 1
other	9	2,887.88	320.88	2.40*
S(C X S) X T	(120)	19,834.82	165.29	
linear	24	6,469.32	269.56	
quadratic	24	3,745.21	156.05	
other	72	9,620.29	133.61	
Total	191	61,729.22		

* $p < .05$

** $p < .01$

The mean durations in each of the four conditions on the six trials appear in Table 2.

Table 2. Mean durations (transformed data) of immobility in four conditions on six trials

Trial	Alarm	Covey	Tone	Blank
1	26.65	35.45	35.84	26.05
2	29.58	34.26	31.61	41.51
3	20.61	32.46	24.73	35.43
4	37.40	27.55	19.40	33.34
5	24.84	20.70	23.16	47.47
6	27.85	16.55	23.26	38.89

These results are presented graphically in Figure 4 (next page). Durations become significantly shorter over trials in both the covey call condition and the tone condition. The alarm and blank conditions maintained immobility.

Sex Differences

The linear component of the Sex by Trials interaction was also significant. The mean durations for the males and females are shown in Table 3 (next page). These data are graphed in Figure 5. It is clear from Figure 5 that the termination of immobility occurs sooner in the later trials for the male subjects.

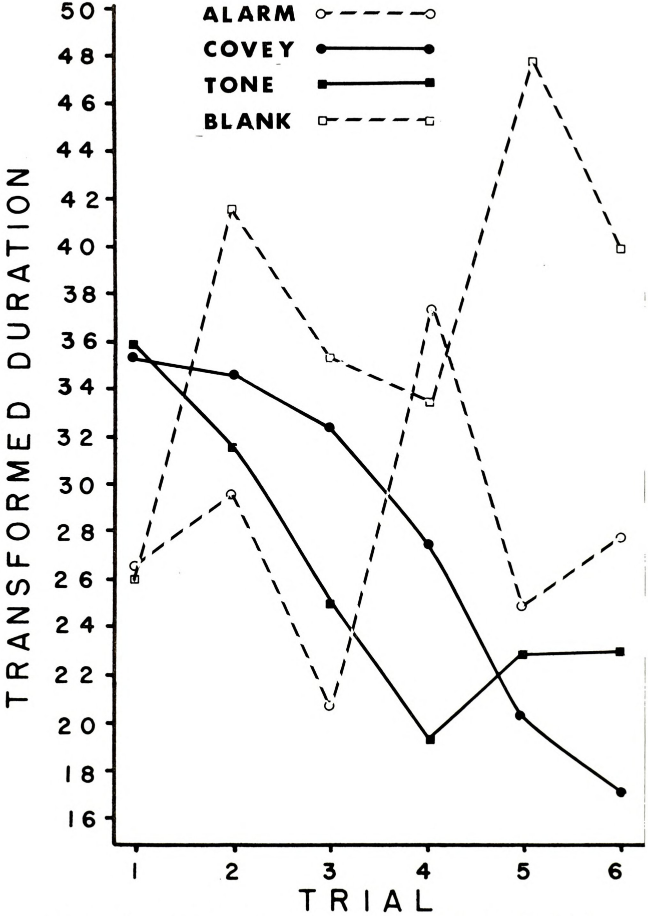

Figure 4. Mean duration for each condition on six trials.

Table 3. Mean durations (transformed data) of immobility for males and females on six trials.

Trial	Males	Females
1	35.34	26.69
2	36.90	31.57
3	23.73	32.88
4	25.88	32.96
5	28.52	29.57
6	22.48	30.79

Table 4. Mean duration for each subject on trials 1,6,13 & 14.

Subject	Trial #1	Trial #6	Trial #13	Trial #14
1	35.99	13.19		
2	26.98	29.21		
3	44.72	26.80		
4	14.46	29.65	11.31	29.34
5	18.03	27.15		
6	29.75	46.48		
7	13.96	13,96		
8	29.31	36.33	19.85	10.00
9	75.15	27.22		
10	19.10	12.17		
11	27.42	7.62		
12	39.33	21.49	12.16	29.46
13	50.04	20.91		
14	31.70	10.34		
15	8.06	9.64	12.61	9.85
16	32.83	21.02		
17	33.88	6.71		
18	45.78	11.66		
19	77.41	48.01		
20	19.39	13.34	38.48	18.52
21	15.03	10.05		
22	60.27	30.41		
23	27.40	59.18		
24	7.55	6.71	6.71	16.94
25	26.66	43.87		
26	45.92	18.57		
27	16.19	17.41		
28	16.52	32.73	16.29	38.96
29	16.22	20.32		
30	21.00	77.46		
31	34.22	23.30		
32	31.70	77.46	59.92	23.39

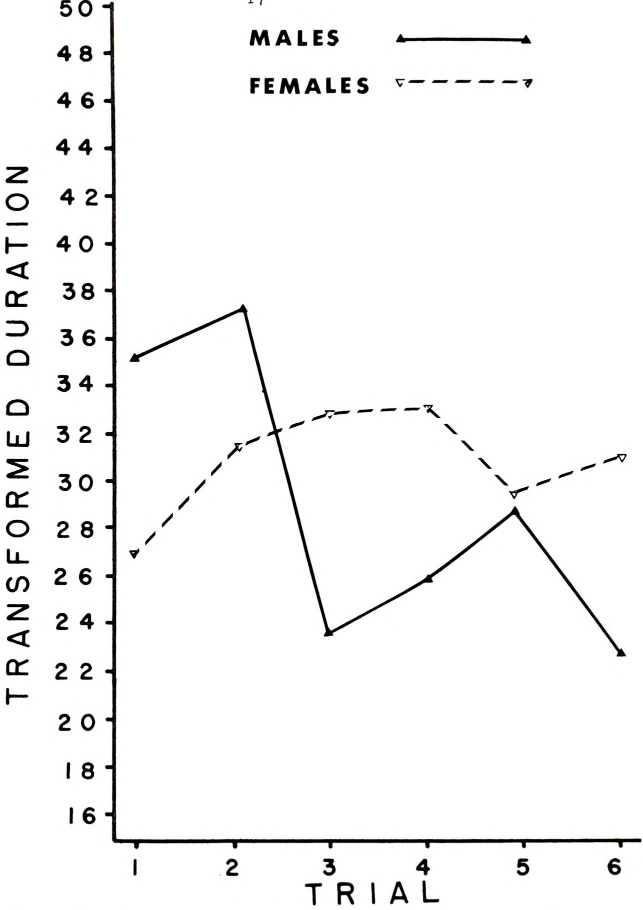

Figure 5. Mean duration for males and females on six trials.

Effects of Repeated Testing

The mean durations of immobility for each S on trials #1 and #6, and for the post-test Ss on trials #13 and 14, appear in Table 4. The means on trials #1 and #6 were compared using the t-test for related measures. The difference was not significant (t=1.07, df=31, NS). This would indicate that habituation did not occur during the first six trials.

Eight birds had received an additional seven trials using the same initial procedure. For these Ss, the mean durations on trials #1 and #13 were compared using the same t-test. Again, no significant difference was found (t=0.59, df=7, NS).

Four of these post-test birds were handled and then re-tested on trial #14. For these birds, durations on trial #1 were compared with durations on trial #14 via the same t-test. There was no significant difference (t=0.025, df=3, NS).

In summary, no evidence for habituation of immobility could be found in this data. The two post-tests which were designed to habituate the response failed to do so.

Reliability

The reliability of immobility duration scores for thirty-two subjects was assessed. The sum of the durations on odd trials was compared to the sum of the durations on even trials using the Spearman Rank Order Correlation Coefficent (rho=.71, p<.05, corrected for ties).

Despite great individual differences (durations ranged from 45 to 6000 seconds), the duration of immobility seems to be a reliable measure for individual Ss.

In summary, analysis of the data yielded four principal results. First, the conspecific vocalizations did have a statistically significant effect on the duration of immobility over trials. Second, a sex difference exists, and males exhibit shorter durations of immobility over trials. Third, no evidence for habituation of the immobility response in these subjects could be found. Finally, the duration of immobility was shown to be a reliable response measure.

DISCUSSION

The purpose of this study was to obtain information relating to three questions. The first was to determine if adult Bobwhite quail are a good preparation for the study of tonic immobility. Following Ratner (1967), an evaluation should include three indices: (1) Can the response be reliably elicited for most individuals? (2) Will the duration of the response be long enough to take behavioral or physiological measures, but not so long as to be experimentally unwieldy? (3) Is the variance in the duration of the response small enough to allow investigation of variables which affect the duration of immobility?

In this study, all of the thirty-two subjects were immobilized on every trial, and the classic tonic posture was exhibited. Usually only one induction was necessary, and never more than two repetitions of the initial induction were needed. Ratner and Thompson (1960) obtained similar results with domestic chicks. Although the induction procedure with chicks included only a 15 second period of restraint (as compared with 30 seconds in this study), Ratner and Thompson found that over 90% of their birds immobilized. Other investigators have failed to specify the percentage of susceptible birds,

but it was implied that most of their subjects immobilized. Gallup, et al. (1970) suggested that all of the domestic chicks, 15 days of age, they tested immobilized. In contrast, Gilman et al. (1950) found that only 40-70% of the adult domestic chickens tested immobilized on the first five trials. They also used 15 seconds of restraint during induction, but at least one third of the birds were restrained on their ventral surface. This method of induction less reliably elicits tonic immobility. Since these adult birds had had some exposure to human beings during routine maintenance, taming may also have functioned to reduce the incidence of immobility.

It seems, therefore, that Bobwhite quail compare favorably with other species of birds in terms of the ease and reliability with which tonic immobility can be elicited. Since tonic immobility is probably an innate response to predators, it is logical that the response can be elicited at least as easily in Bobwhite quail as in domestic birds.

Gallup, et al. (1970) used a procedure in which domestic chicks 15 days old received electric shock before induction of immobility by restraint. The experimenters obtained a mean duration of 298.42 seconds for shocked chicks which had not been previously handled. The mean duration of a comparable group of chicks which did not receive shock before induction was 153.58 seconds. Gilman, et al. (1950) recorded mean durations of immobility in adult domestic chidkens ranging from 220 to

230 seconds. Since Ratner and Thompson (1960) terminated immobility in their domextic chicks at four minutes, a measure of total duration was not taken.

In comparison with the above studies, the mean durations of immobility in the present study were 1058 seconds (Tone), 1026 seconds (Covey Call), 956 seconds (Alarm Note), and 1793 seconds (Blank) for the four experimental conditions. In general, therefore, the durations were longer for adult Bobwhite quail than for domestic birds. With the exception of one bird, the median duration for each subject exceeded two minutes. Several birds remained immobile longer than thirty minutes on at least one trial. One bird remained immobile for 6000 seconds (at which time immobility was artificially terminated) on five consecutive trials. While such long durations are of interest and may be useful in some areas of research (e.g. implantation of electrodes to monitor physiological responses), they limit the number of birds which can be tested during a session. Research to investigate habituation of tonic immobility and variables which affect the duration of or terminate immobility is needed. For such studies, the reliable occurrence of very long durations of immobility in adult Bobwhite quail would be undesirable, and a domestic species exhibiting shorter durations might be a more appropriate preparation. An alternative would be the use of an habituation procedure (if, indeed, the immobility response can be habituated in adult Bobwhite quail) to eliminate the very long durations.

The second question to which this research was directed concerned the effect of two conspecific vocalizations, the alarm note and the covey call, on the duration of immobility. Other investigators have noted that sudden loud noises can terminate immobility (Ratner, 1967). Ratner found that a sudden loud noise produced a dramatic increase in heart rate of immobile pigeons. This evidence suggests that birds are receptive to auditory stimuli during immobility, although this receptivity may not be manifested in overt behavior. If this were true for Bobwhite quail, it might be assumed that two vocalizations with widely divergent natural functions would have differential effects on the duration of immobility. Such is the case. While the Conditions main effect was not significant, the significant linear component of the Conditions by Trials interaction demonstrates that the vocalizations produce different results over time. Both the covey call and the tone resulted in shorter durations over trials.

Two explanations of this result are offered here. First, following the original hypothesis, the effect of the covey call may be to reduce "fear" or arousal in the birds. This reduction in fear could well be cumulative from trial to trial. Such a change in the arousal of the subjects could then allow habituation of the tonic immobility response to begin. Similarly, the alarm note may elicit or maintain a higher level of "fear" (arousal), preventing immobility from habituating. The tone, a

condition which also produced a significant decrease in durations over trials, might be functioning as an auditory model of the covey call. Although the tone is the mean frequency and duration of the alarm and covey calls, to the human ear of the experimenter it more closely resembles the covey call.

The second explanation considers the tone only as a probe rather than a model of the covey call. Doty (1969) demonstrated that the presence of a visual probe (a revolving nystagmus drum) could significantly reduce the duration of immobility in Bobwhite quail. The tone (and, indeed, the covey call) might be functioning in a similar fashion, while the alarm note would still serve to maintain "fear" and lengthy durations of immobility. This second explanation would also account for the consistently lengthy durations in the Blank condition. It furthermore places greater emphasis on the "message" contained in the alarm note.

The Sex by Trials interaction was significant, and males tend to exhibit shorter durations of immobility over trials. No explanation for this result is currently available to the author.

The third question to which this study was addressed concerned the habituation of the immobility response. Other investigators have reported a decrease in durations of immobility with repeated, spaced test trials. Gilman, et al. (1950) tested domestic chickens twice each day for twenty-one days and obtained a decrease in mean durations

of approximately 200 seconds. Ratner and Thompson (1960) tested domestic chicks three times at weekly intervals. The median duration decreased from over 700 seconds (sum of three trials) in the first session at ten days of age to 14 seconds at 66 days of age. Gallup, et al. (1970) employed pre-experimental procedures which reduced ths susceptibility to immobility of domestic chicks. The birds were immobilized five times each day until the duration of the first immobilization was no longer than 30 seconds for two consecutive days. It was implied that this repeated testing reduced the duration of immobility. Criterion was reached in an average of 7.45 days.

In these three studies (Gilman, et al., 1950; Ratner and Thompson, 1960; Gallup, et al., 1970) twenty to twenty-five trials, spaced in time, were sufficient to habituate the immobility response. The present study used only six trials for twenty-four of the subjects, and the immobility response did not habituate. The eight birds that received fourteen trials and handling also did not evidence any habituation. This result does not contradict the results of previous studies since the birds received fewer trials than subjects in earlier research. It does, however, provide further evidence that the immobility response is very resistant to habituation, which is ecologically valid. If the immobility response were easily habituated, its value in reducing the probability of attack by a predator would be lost. It is also likely that the novelty of the experimenter was

maintained through the use of blue light when in the presence of the birds. Thus, maintenance of the animals did not influence the test situation. Further research using a similar procedure but shorter intertrial intervals and an increased number of trials may be necessary to demonstrate the habituation of tonic immobility in Bobwhite quail.

In summary, adult Bobwhite quail have been evaluated as subjects of the study of tonic immobility. Conspecific vocalizations have been shown to influence the duration of tonic immobility. Repeated testing and a handling procedure both failed to habituate the immobility response. It was suggested that further research using more trials and a shorter intertrial interval might demonstrate habituation of tonic immobility.

REFERENCES

Armstrong, E. A. Bird Display and Behavior. New York: Dover, 1965.

Bayard, J. The duration of tonic immobility in guinea pigs. J. comp. physiol. Psychol., 1957, 50, 130-133.

Borchelt, P. L. The development of fear displays in Bobwhite quail (Colinus virginianus). Unpublished Masters Thesis, 1970, Michigan State University.

Denny, M. R., & Ratner, S. C. Comparative Psychology, Rev. Ed. Homewood Ill.: Dorsey, 1970.

Doty, R. L. The effect of environmental movement upon the duration of tonic immobility in Bobwhite quail. Pschonomic Science, 1969, 16, 48-49.

Gallup, G. G., JR., Creekmore, H. S., & Hill, W. E., III. Shock-enhanced immobility reactions in chickens: Support for the fear hypothesis. Psychol. Rec., 1970, 20, 243-245.

Gilman, T. T., Marcuse, F. L. & Moore, A. U. Animal hypnosis: A study in the induction of tonic immobility in animals. J. comp. physiol. Psychol., 1950, 43, 99-111.

Hoagland, H. The mechanism of tonic immobility. Journal of General Psychology, 1928, 1, 426-447.

Klemm, W. R. Electroencephalography-Behavioral Dissociations During Animal Hypnosis. Electroencephalography and Clinical Neurophysiology, 1966, 21, 365-372.

Liberson, W. T. Prolonged hypnotic states with local signs induced in guinea pigs. Science, 1948, 108, 40-41.

Liberson, W. T., Smith, R. W., & Stern, A. Experimental studies of the prolonged "hypnotic withdrawal" in guinea pigs. Journal of Neuropsychiatry, 1961, 3, 28-34.

Mowrer, O. H. A note on the effect of repeated hypnotic stimulation. Journal of Abnormal and Social Psychology, 1932, 27, 60-62.

Ratner, S. C. Hypnotic reactions of rabbits. Psychol. Rep., 1958, 4, 209-210.

Ratner, S. C. Comparative aspects of hypnosis. In J. Gordon (Ed.), Handbook of clinical and experimental hypnosis. New York: Macmillan, 1967.

Ratner, S. C. & Thompson, R. W. Immobility reactions (fear) of domestic fowl as a function of age and prior experiences. Anim. Behav., 1960, 8, 186-191.

Stoddard, H. L. The Bobwhite quail: Its habits, preservation, and increase. New York: Scribners, 1931.

Sturkie, P. D. Avian physiology. (2nd ed.) Ithaca: Cornell University Press, 1965.