The effect of escape responses on immobility in bobwhite quail (*Colinus virginianus*)

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Bobwhite quail tested for the immobility response to manual restraint were more susceptible to immobility and remained immobile longer under conditions which elicited escape responses prior to immobility than under a condition which prevented escape responses. The results, discussed in terms of a defensive-distance model, suggest a relationship between immobility and other responses to predators such as escape.

The immobility response to manual restraint has been reported in a wide variety of species (see review by Ratner, 1967). Numerous theoretical explanations for the response have been proposed, such as hypnosis and cerebral inhibition, but recent research has supported the idea that the immobility response is a fear reaction. Standard fear-inducing stimuli, such as electric shock (Gallup, Creekmore, & Hill, 1970) and loud noise (Gallup, Nash, Potter, & Donegan, 1970) presented immediately prior to an immobility test, have increased the durations of immobility in domestic chickens. Furthermore, procedures designed to reduce, rather than increase, fear have led to decreases in durations of immobility. In domestic chickens, handling, familiarization, or "taming" decreases durations of immobility (Gilman, Marcuse, & Moore, 1950), and repeated testing causes habituation of immobility responses (Ratner & Thompson, 1960). Another procedure, the administration of a tranquilizer, also decreases the duration of immobility responses in domestic chickens (Gallup, Nash, & Brown, 1971).

Ratner (1967) has suggested that immobility is a response to a predator and that the response is typically preceded by a sequence of other responses that are a function of the distance between the prey and the predator. This defensive distance model proposes that at a long defensive distance, the prey freezes. As the distance is reduced, the prey makes escape responses and then may fight as the distance is reduced to zero. At a prolonged zero defensive distance, the prey may respond by immobility. In laboratory studies of immobility, where the predator is the E, these other responses (usually freezing and escape) have been observed but have generally been ignored as variables or behaviors related to immobility.

One way to conceptualize the effects of electric shock, loud noise, and tranquilizers on immobility

responses is to consider that they modify in some way these earlier responses in the sequence. Thus, electric shock and loud noise may elicit freezing and/or escape responses, which in turn lead to an increase in duration of immobility. Conversely, "taming" and tranquilizers reduce these responses and also reduce the duration of immobility.

Previous studies have generally not measured or recorded the responses directly elicited by the fear-inducing or -reducing stimuli. The purpose of the present study is to directly manipulate escape responses to a predator (E) and to determine the effect of such responses on immobility in bobwhite quail. Bobwhite quail were chosen as experimental animals, since they are less domesticated than chickens and they exhibit the immobility response when restrained by a human (Doty, 1969).

SUBJECTS

Fifteen 3-year-old bobwhite quail (*Colinus virginianus*), 7 female and 8 male, were obtained from the Michigan State University Department of Poultry Science quail colony. Food (Quail Breeder, King Milling Co., Lowell, Mich. 49331) and water were continuously available. Lighting was continuous except during testing.

APPARATUS

The apparatus consisted of three cages, each 97 x 45 x 33 cm. A 45-cm 15-W warm white fluorescent tube was fastened to the top of each cage. In two of the cages, the bulbs were covered with dark blue plastic, providing dim blue illumination (wavelength from 427 to 534 nm as determined by a Gaertner L231 wavelength spectrometer). Many birds are particularly insensitive to blue, presumably due to the presence of orange-, yellow-, or red-colored oil droplets in the cone cells (Sturkie, 1965, p. 416). Pilot research had indicated that under dim blue illumination, bobwhite quail did not make escape responses when the E reached into the cage. Thus, we concluded that Ss could not see under

these conditions. An identically covered bulb was fastened above an adjacent table upon which the birds were tested.

PROCEDURE

The Ss were divided randomly into three groups of five birds each. Each group was treated as follows: *Dark/no escape* (DNE, three male, two female)—Fifteen minutes before testing, the room lights were turned off and the blue light in the cage was turned on. Each S was taken from the cage and tested for immobility under dim blue illumination. *Dark/10-sec escape* (DE, three male, two female)—Fifteen minutes before testing, the room lights were turned off and the blue light in the cage was turned on. The E chased each S around the cage with his hand for 10 sec before testing the S for immobility under dim blue illumination. *Light/10-sec escape* (LE, three female, two male)—Each S was both chased for 10 sec and tested for immobility with the room lights on. The procedure for testing immobility consisted of grasping each S and restraining it on its back for 10 sec. The E then slowly released his hands and recorded the incidence and duration of immobility. If S righted itself immediately after release, it was given a score of zero duration. No arbitrary upper limit was placed on recording duration of immobility.

During recording for all three groups, each S was positioned on the table so that, while immobile, it could be observed by the E who remained behind a partition out of view of the bird. To insure reliability of immobility durations, each S in each group received three immobility tests, with an interval of 7 days between tests. The immobility duration score for each S was the median score of the three tests.

RESULTS

The procedures were successful in manipulating escape responses. No escape responses (defined as vigorous avoidance of E's hand) were made in Group DNE, while escape responses were made by all birds in Groups DE and LE. The effect of escape responses on the duration of the immobility response is shown in Fig. 1. The median duration of immobility for birds in Group DNE was 0 sec (range from 0 to 398 sec), while the median duration and ranges in Groups DE and LE was 235 sec (range from 0 to 2,062 sec) and 176 sec (0 to 1,666 sec), respectively. A Kruskal-Wallis test (Siegel, 1956) revealed the overall difference between groups to be statistically significant ($H = 8.5$, $p < .01$). Mann-Whitney U tests between individual groups revealed a significant difference

Fig. 1. The median duration (in seconds) of immobility in Groups DNE (dark, no escape), DE (dark, escape), and LE (light, escape).

between Groups DNE and DE ($U = 0$, $p = .004$) and Groups DNE and LE ($U = 2.5$, $p = .022$). The difference between Groups DE and LE, both of which had escape experience, was not significant ($U = 7$, $p = .155$).

The presence of escape responses also affected incidence of immobility. A total number of three immobility responses (out of 15 trials) occurred in Group DNE, while the total number of immobility responses occurring in Group DE was 11 and in Group LE was 13. Groups DE and LE both had significantly more immobility responses than Group DNE ($\chi^2 = 7.87$, $p < .01$; $\chi^2 = 10.85$, $p < .001$, respectively). The difference between Groups DE and LE was not significant ($\chi^2 = .21$, $p > .5$).

DISCUSSION

These results show that the differences between the groups in both incidence and duration of immobility responses was not a function of illumination per se but was due to the presence or absence of escape responses. Thus, chasing the bird (eliciting escape responses) increases the probability that the bird will respond by immobility and also increases the duration of the immobility response. While the results support, and extend to a less domesticated species, the results of other studies (Gallup, Creekmore, & Hill, 1970; Gallup, Nash, Potter, & Donegan, 1970) which show that "fear-inducing" stimuli increase the duration of immobility responses, they

also suggest that the actual description of the response elicited by such stimuli would allow for analysis of the relations between immobility and the other responses in the sequence of responses to predators suggested by Ratner (1967). One relation between these responses provided by the present study is that the elicitation of responses earlier in the sequence (such as escape) increases both the incidence and duration of the terminal response in the sequence (immobility). Further research is necessary to determine the relations between other defensive responses, such as freezing, fighting, and immobility.

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