Effect of food deprivation and a visual cliff on tonic immobility*

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Contrary to the contention that generalized arousal is the common denominator of situations designed to enhance tonic immobility, the effect of food deprivation on immobility time and ease of eliciting the reaction was found to be negligible in an experiment using chickens. On the other hand, enforced suspension over a visual cliff, in a second experiment, was found to be an effective technique for prolonging immobility. The implications of these data for the fear hypothesis were discussed.

Tonic immobility consists of an apparent state of temporary paralysis following a brief period of manual restraint. The literature on tonic immobility spans over 300 years, and a variety of interpretations have been advanced to account for the reaction (Ratner, 1967). While some still feel that the response may be the prototype of human hypnosis, an increasingly popular explanation has been that it is mediated by fear (e.g., Ratner & Thompson, 1960). Recent studies (e.g., Gallup, Rosen, & Brown, 1972) have shown that laboratory conditions designed to increase fear, such as electric shock, loud noise, and aversive conditioning, all serve to increase or exaggerate the duration of immobility in domestic chickens. Similarly, the application of procedures for reducing fear serve to abbreviate the response (Gallup, Nash, & Brown, 1971; Salzen, 1963).

A possible objection to many studies designed to test the fear hypothesis might be that the experimental procedures serve only to alter the organism's generalized state of arousal and that any such change is a sufficient condition for immobility manipulation. In other words, it could be argued that, to date, fear has not been demonstrated as being the critical antecedent of immobility potentiation, but rather is simply one of many ways of producing changes in nonspecific arousal.

Another criticism of the notion of fear-induced changes in tonic immobility is that most studies have employed exceedingly atypical fear stimuli. No contemporary terrestrial animal, for example, seems to have evolved under conditions of electric shock. Historically, shock has not been a natural habitat ingredient of most ecosystems, yet it has become one of the most popular aversive stimuli for investigators in many areas of animal

behavior. Similarly, tranquilizers and unusual noises of the type used in most studies would not ordinarily be encountered under natural conditions.

The present study attempts to circumvent these two objections.

EXPERIMENT 1

In the first experiment, 24 h of food deprivation was employed as a means of manipulating arousal independent of fear for both naive and habituated chickens. If the arousal hypothesis is a tenable interpretation of tonic immobility, then one might expect food deprivation to increase the duration of the reaction. On the other hand, if fear is the critical antecedent of laboratory-induced changes in immobility, then food deprivation should have no effect.

Method

The Ss were 32 straight-run Production Red chickens (*Gallus gallus*) obtained from a local hatchery at 1 day of age. During rearing, all chicks were housed in commercial brooders and given continuous access to Purina Chick Chow (Growena) and water under conditions of a 14-h photoperiod at room temperature of approximately 22°C.

Upon reaching 3 weeks of age, the birds were divided randomly into two groups for testing. The Ss in one group were given 3 days of habituation training, which consisted of immobilizing each bird five times each day according to the procedure described by Gallup, Nash, & Wagner (1971). Following the habituation phase, half the birds in each group were deprived of food for 24 h prior to testing, thus yielding a 2 by 2 factorial design with eight Ss per cell.

Testing consisted of manually restraining a chick on its right side for 15 sec on a table and recording the subsequent duration of immobility from the time restraint ended until the bird rose to its feet. If a S failed to become immobile following the initial application of restraint, it was given successive 15-sec inductions until immobility ensued or until five

inductions had been administered. During both the habituation and testing phase of the experiment, large plywood boxes perforated with holes were used to transport birds to the testing area and served as holding containers situated outside the test room.

Results

In spite of obvious home cage behavioral differences between the hungry and satiated birds in terms of both increased activity and vocalization levels, the effect of food deprivation on immobility was negligible. The mean duration of immobility for deprived Ss was 284.06 sec as compared with 317.81 sec for satiated birds. Due to appreciable heterogeneity of variance, the raw scores were transformed [$\log_{10}(X + 1)$] for purposes of analysis. A two-factor analysis of variance showed that the main effect of deprivation failed to reach statistical significance ($F = .19$, $df = 1/28$) and that the Deprivation by Habituation interaction was also nonsignificant ($F = .13$, $df = 1/28$). The only appreciable effect on tonic immobility resulted from the habituation procedure ($F = 23.87$, $df = 1/28$, $p < .001$), with habituated birds showing a mean immobility time of 77.87 sec as compared with 524 sec for naive chicks.

In terms of the number of inductions required to elicit the reaction, analysis of the raw data yielded comparable results. Both the main effect of deprivation ($F = .65$, $df = 1/28$) and the interaction ($F = .07$, $df = 1/28$) proved nonsignificant. Only the habituation procedure produced a significant effect on susceptibility to immobility ($F = 5.85$, $df = 1/28$, $p < .025$), with habituated birds requiring an average of 2.50 inductions and naive chicks only 1.38.

EXPERIMENT 2

Through the use of a visual cliff, the second experiment was designed to preclude objections to the fear hypothesis based on the use of ecologically atypical fear stimuli.

Method

The Ss were 45 Production Red chickens obtained and maintained similarly to those used in the previous study.

At 3 weeks of age, the birds were divided randomly into three groups and all received 4 days of habituation training. On the day following the last habituation trial, birds in one group were immobilized on the center of a clear piece of thick Plexiglas, measuring .93 x .45 m, which was suspended .80 m above a gray concrete floor by placing each end on one of two adjacent table tops separated by a distance of approximately 60 m. Birds

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Fig. 1. Average duration of tonic immobility in chickens as a function of the stimulus conditions in effect during testing.

in the other two groups served as controls and were immobilized on the Plexiglas surface, which was placed directly over one of the wooden table tops or positioned flat on the floor between the two tables.

The testing procedure was identical to that in effect during the first experiment, with unresponsive chicks receiving up to five successive 15-sec inductions. So as to preclude responding to extraneous cues, the Plexiglas surface was cleaned prior to testing each bird and illumination was provided by direct overhead fluorescent lights.

Results

Suspension over a visual cliff during induction and recording of tonic immobility increased both susceptibility to immobility and duration of the reaction. The duration data are graphically depicted in Fig. 1. For purposes of analysis, the duration scores were transformed [$\log_{10}(X + 1)$] and a simple between-groups analysis of variance yielded a significant effect of treatments ($F = 8.67$, $df = 2/42$, $p < .001$). In terms of individual comparisons, Duncan's multiple range test showed that the duration of immobility in the visual cliff condition was significantly greater ($p < .01$) than

either of the two controls, whereas the difference between control conditions did not reach statistical significance.

For the number of inductions needed to elicit immobility, a between-groups analysis of variance also showed a significant treatments effect ($F = 12.03$, $df = 2/42$, $p < .001$), with mean inductions of 2.53 for birds immobilized on the visual cliff and 4.67 and 4.47 for those tested on the table or the floor. Duncan's test again showed that Ss confronted with the visual cliff required significantly fewer ($p < .01$) inductions than either of the controls, with the difference between control conditions not being significant.

DISCUSSION

Data from Experiment 1 failed to support the contention that tonic immobility may be related to sources of nonspecific arousal. Both habituated and naive birds subject to 24 h of food deprivation did not differ significantly from nondeprived controls in terms of either duration or number of inductions needed to elicit the reaction. Thus, deprivation-induced changes in arousal would not appear to be critically related to tonic immobility in chickens.

In an attempt to contrive a more ecologically relevant or natural fear

situation, the effect of a visual cliff was examined in the second experiment. In concert with the fear hypothesis, enforced suspension over a visual cliff was found to be an effective means of enhancing immobility duration. Birds immobilized in the cliff condition remained immobile approximately 11 times longer than those tested on the floor and over 4.5 times longer than those restrained on a table top. In terms of number of inductions, visual cliff confrontation also increased the probability of becoming immobile following manual restraint.

It should be made clear that the data from both these experiments, as well as those of other investigations, do not necessarily implicate fear as being the cause of immobility. Fear alone is obviously not a sufficient condition for the elicitation of tonic immobility, because proprioceptive and tactile input (Klemm, 1971) in the form of manual restraint are also needed. These data merely augment the notion that fear is an important antecedent condition of immobility manipulation in chickens.

REFERENCES

- GALLUP, G. G., JR., NASH, R. F., & BROWN, C. W. The effects of a tranquilizer on the immobility reaction in chickens: Additional support for the fear hypothesis. *Psychonomic Science*, 1971, 23, 127-128.
- GALLUP, G. G., JR., NASH, R. F., & WAGNER, A. M. The tonic immobility reaction in chickens: Response characteristics and methodology. *Behavior Research Methods & Instrumentation*, 1971, 3, 237-239.
- GALLUP, G. G., JR., ROSEN, T. S., & BROWN, C. W. Effect of conditioned fear on tonic immobility in domestic chickens. *Journal of Comparative & Physiological Psychology*, 1972, 78, 22-25.
- KLEMM, W. R. Neurophysiologic studies of the immobility reflex ("animal hypnosis"). In S. Ehrenpreis and O. C. Solnitzy (Eds.), *Neuroscience research*. Vol. 4. New York: Academic Press, 1971. Pp. 165-212.
- RATNER, S. C. Comparative aspects of hypnosis. In J. E. Gordon (Ed.), *Handbook of clinical and experimental hypnosis*. New York: Macmillan, 1967. Pp. 550-587.
- RATNER, S. C., & THOMPSON, R. W. Immobility reactions (fear) of domestic fowl as a function of age and prior experience. *Animal Behaviour*, 1960, 8, 186-191.
- SALZEN, E. A. Imprinting and the immobility reactions of domestic fowl. *Animal Behaviour*, 1963, 11, 66-71.