The effect of environmental movement upon the duration of tonic immobility in bobwhite quail¹

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Five mature Bobwhite quail (Colinus virginianus) were immobilized inside an optokinetic nystagmus drum in a repeated measurements design under rotation and nonrotation conditions. The duration of immobility was significantly longer in the nonrotation condition, suggesting the importance of visual stimulation in terminating the response. The correlation between the two conditions was +.79. It is suggested that studies of self-paced termination of "tonic immobility" may be measuring not only an analgesic and unresponsive "trance state," but also a freezing display subsequent to this so-called "state."

Immobility reactions of animals (sometimes termed "animal hypnosis") to human handling has been the subject of scientific investigation for several hundred years (Ratner & Thompson, 1960). A major theoretical and practical problem has been encountered in numerous attempts to define the so-called tonic immobility "state." Coupled with vast inter- and intraspecies differences, reliable measurements of the phenomenon have not been forthcoming. The most often-used measure of immobility reactions has been the duration of the immobility, i.e., the time from the onset of the reaction until the organism makes a gross movement from the position in which he had been immobilized (e.g., Bayard, 1957; Hoagland, 1932; Mowrer, 1932; Liberson, 1948; Liberson, Smith, & Stern, 1961; Ratner, 1958; and Ratner & Thompson, 1960). Although suggestions have been made concerning the effects of the intensity or duration of environmental stimulation required to terminate immobility (Liberson et al, 1961; Ratner, 1958), there has been no systematic investigation of the effect of visual stimulation in terminating the response. Ratner (1967, p. 566) points out that the data and conclusions regarding externally produced termination are subject to two confounding factors: (a) self-paced termination may coincide with the presentation of the external stimulus, and (b) since one of the typical characteristics of "hypnotic" reactions is that animals are unresponsive or analgesic during immobility, the termination in response to stimulation may indicate that the reaction

has ceased. The present study sought to determine the relation between a visually demanding, rotating environment and the termination of the immobility response in Bobwhite quail. Specifically, it was hypothesized that immobilized Ss within an optokinetic nystagmus drum would terminate the immobility response sooner when the drum was in motion than when it was stationary.

SUBJECTS

The Ss were three male and two female 6-month-old Bobwhite quail (*Colinus virginianus*). All had been previously used in a two-trial immobility study.² The Ss were housed in two separate cages for several days before the study. Both water and feed were available to the Ss at all times.

APPARATUS

The testing was carried out on a 9 x 6½ in. platform suspended inside a 16-in.-diam optokinetic drum. The inside surface of the drum consisted of ¾-in.-wide white and 11/16-in.-wide black alternating vertical stripes. The drum could be rotated at a constant speed of 7 rpm. The entire apparatus was located inside a near-soundproof room adjacent to the room housing the Ss. In an effort to eliminate possible extraneous sounds produced either by the motor of the apparatus or by E, a white-noise generator was on at all times. A stopwatch was used to measure the duration of the immobility.

PROCEDURE

The present study used a repeated measurements design, and the Ss were randomly assigned to either the rotating drum or the nonrotating drum first-trial condition. The E brought each S from its home cage into the testing situation with its head covered, placed it on its left lateral side on the platform, and held it there, with its head covered, with a firm pressure over its entire body for 15 sec. At the end of the 15-sec induction, the E slowly removed his hands from S and sat in a chair located about 4 ft from the drum, quietly observing and taking notes. An assistant, who sat in an adjacent corner of the room, timed the 15-sec induction. The duration of the response included the 15-sec induction time. Termination of the response was recorded when the bird got to its feet. An arbitrary maximum duration of 20 min of immobility was established. If the S had not risen to its feet after 20 min, it was lifted, righted, and allowed to stand for a few seconds. The

Table 1
Duration of Immobility (Seconds) Under Two Conditions of Visual Movement

Subject	Condition	
	Rotating Drum	Nonrotating Drum
1	98	288
2	173	580
3	82	180*
4	180***	1200**
5	15	231
Mean	109.6	495.8
SD	61.4	378.4

* Premature termination - E error

** Arbitrarily terminated at 1200 sec

*** Eyes closed for approximately 120 sec from start of induction

second induction (condition) began approximately 15 sec following the termination of the first condition.

RESULTS

The durations of the immobility responses for each S are presented in Table 1, along with the mean and standard deviations for each of the two treatments. It is evident from Table 1 that the rotating drum produced much shorter durations of immobility than the stationary, nonrotating drum, lending support to the hypothesis. A t test for correlated samples found the difference between the means of the two conditions to be significant beyond the .05 level ($t = 2.3$, $df = 4$, one-tailed test). Since, as noted in Table 1, one S in the nonrotating condition was arbitrarily terminated at 20 min, and another S in this same condition was accidentally terminated when E made a slight movement, a higher level of statistical significance may have been expected.

Another important finding evident from Table 1 is the high correlation between the two conditions. The Pearson product-moment correlation coefficient between the two conditions was +.79 ($p < .01$, $t = 6.5$, $df = 3$, two-tailed test).

DISCUSSION

The data suggest that moving visual stimulation results in a more rapid termination of the tonic immobility response than stationary visual stimulation. These results are in general agreement with various more-or-less anecdotal reports of the use of sounds in terminating the immobility response (Liberson, 1948; Liberson et al, 1961; Ratner, 1958).

Subjects 1 and 2 were tested in the rotation condition first, and the remaining Ss were tested in the nonrotation condition first. The data in Table 1 do not disclose any order effects.

The +.79 correlation between the two conditions is an interesting finding, with little or no support from the literature. The small number of Ss, however, requires that interpretation of this correlation must be

very conservative, even though the correlation is statistically significant. Tentatively, however, it appears that each S maintained a relatively constant position within each condition.

The results of the present study, along with a critical review of the discrepant literature, suggest an interesting hypothesis for future investigation. It may be, at least in *Colinus virginianus*, that natural (self-paced) termination of tonic immobility is a measure of not only the so-called state of analgesia, etc., associated with "animal hypnosis," but also freezing behavior subsequent to this state, in which the organism is more responsive to external stimulation. If the high correlation between the termination times of Ss under the two conditions of visual stimulation of the present study is replicated in the future, it would appear that important internal organismal factors are intimately linked with the termination of both measures of immobility. Research is now being planned to investigate this extremely speculative hypothesis in greater depth.

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NOTES

1. I am grateful to Dr. Stanley Ratner, Dr. Lauren Harris, Dan Gutkin, and the members of Psychology 802 for their help in the formulation of this study.

2. Ratner, S. C. Unpublished manuscript.

SUBJECTS

Three patients, one female and two males aged 67, 41, and 58 years, respectively, with left hemiplegia resulting from a cerebrovascular accident (CVA), acted as Ss. The female S (F-1) had sustained a CVA 6 months prior to experimentation; the two male Ss (M-1 and M-2) had CVAs which occurred 9 months and 10 months, respectively, prior to the study.

All Ss were given a neurological examination before the research was begun,¹ and all were judged to have nonfunctional left upper extremities. S F-1 indicated shoulder elevator and rotator muscles at grade trace, and shoulder abductor, flexor, and extensor at grade zero. Both Ss M-1 and M-2 graded zero on all muscle tests, and both had severe spasticity in the left arm.

APPARATUS AND PROCEDURE

An initial baseline of elbow flexion was obtained for all Ss. Since elbow flexion is a relatively gross and simple response, and is easier for the hemiplegic to execute than finer movements, this was felt to be an appropriate response to attempt to modify in an initial study. Over a period of 50 sessions, lasting 15 min each, no S was able to voluntarily make a single elbow flexion. Then the Ss were randomly assigned to either escape or avoidance conditions. Ss F-1 and M-1 received escape conditioning treatment, while avoidance conditioning was employed with S M-2.

In both conditions of the experiment the forearm of each S's nonplegic upper extremity was held immobile by taping it to the arm of the wheelchair. To this forearm were attached two copper electrodes, one on the above and one on the under side of the forearm. The forearm was lightly rubbed with sandpaper to decrease skin resistance, and the electrodes were lightly sheathed in thin canvas that had been soaked in saline solution. The plegic upper extremity was positioned on a wooden board that was clamped to the other arm of the wheelchair, remaining free to move. Attached to this board by a wingnut was a wooden arm that could be raised or lowered to any desired degree by the E. On the end of this arm was mounted a microswitch.

In the escape situation, the S received an electric shock to the forearm of the nonplegic upper extremity which could be terminated only by a flexion response of the plegic arm so that his hand hit the microswitch that turned off the current. The shock was presented for a 10-sec period. If S did not respond within this time the shock terminated automatically and remained off for 5 sec. The current intensity varied per session for S M-1 from 2.5 to 3.4 mA, and

Escape and avoidance conditioning of responses in the plegic arm of stroke patients: A preliminary study

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Three patients with hemiplegia resulting from cerebrovascular accidents were treated with escape and avoidance conditioning techniques designed to increase responding in the affected upper extremity. Using forearm flexion as the critical response class, two Ss received escape conditioning and one S received avoidance conditioning. One S in the avoidance condition and one S in the escape condition showed no significant increases in responding above baseline. Marked changes were recorded for the other S in the escape situation. Flexion responses were considerably increased from baseline, muscle power in the involved extremity was strengthened, and there was generalization of responding from the laboratory to activities of daily living. It is concluded that motor return in hemiplegia can occur as late as 6 months post-brain injury if appropriate modification procedures are employed.

Studies conducted over the years in which the functional motor return of hemiplegics

has been investigated have been concerned with neurophysiological changes (Twitchell, 1951), learning of simple tasks (Van Buskirk, 1954), motion at the joints (Bard & Hirschberg, 1965), and the performance of daily activities (Carroll, 1967). These investigations have involved the observation of this return without attempting to modify its rate or topology through experimental manipulation of the actual critical response. The present study represents an attempt to influence the motor return directly in the involved upper extremity of individuals who have sustained a cerebrovascular accident.

The techniques employed were escape and avoidance conditioning, as they have been demonstrated to be effective with both animal and human Ss, with a variety of responses. In addition, since hemiplegic patients generally have sensory losses in the affected extremities, these methods appeared appropriate for this population, as work has been done conditioning responses in the deafferented limbs of monkeys (Taub & Berman, 1963; Taub, Bacon, & Berman, 1965).