# THE EFFECTS OF PRIOR FOOT SHOCK UPON BAR PRESSING FOR INTRACRANIAL STIMULATION

by

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B. S., Highlands University, 1964

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A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

Approved by:

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# CHAPTER I

## Introduction and Review of the Literature

Changes in magnitude of reinforcement during the course of an experiment are usually accompanied by appropriate shifts in S's performance. If the level of performance at the new quantity of reward exceeds that of a group of Ss run only at that magnitude, a "contrast effect" is said to have occurred (Crespi, 1942; Zeaman, 1949). Thus, the rewarding value of the new quantity of reinforcement apparently depends not only upon its absolute magnitude but also upon the S's past experience with other quantities of reward. Experimental evidence supporting such a relativity of reward position derives from three classes of experiments: (a) studies employing a paradigm similar to that indicated above in which the S is given experience with one magnitude of reward either before or during testing, and is then switched to a different magnitude (Logan, *et al.*, 1955; Collier and Marx, 1959; Ehrenfreund and Badia, 1962); (b) studies in which periods of no reinforcement are interspersed in sequences of reinforced behavior (Lauer and Carterette, 1959; Adamson, Bevan, and Maier, 1961); and (c) studies in which the S is forced to learn to choose the larger of two magnitudes of reward (Goldstein and Spence, 1963; Hill and Spear, 1963).

Representative of the first type of study is an experiment by Collier and Marx (1959) in which three groups of rats were magazine trained in a Skinner box to sucrose reinforcements of 4%, 11.3%, and 32% respectively for a period of ten days. Following such training all animals were shifted to an 11.3% reward for lever pressing. The results clearly indicated that the group which had been magazine trained for a 4% reward learned the lever-pressing response fastest, and the group magazine trained to the 32% reward learned the response slowest. The 11.3% group was intermediate between the other two.

On the other hand, the contrast phenomenon has not always been observed. Goodrich and Zaretsky (1962) failed to obtain it when they attempted to extend the Collier and Marx findings to the runway situation. Specifically, they pretrained each of three groups of rats to drink one of three sucrose solutions (3%, 11%, and 32%) in a situation similar to that of the runway goal box. Following such training, all groups received sixty trials in the runway with the 11% sucrose concentration used as the reinforcement. In addition to a failure to obtain contrast effects, it was found that the 32% - 11% group ran significantly faster than the other groups. Metzger, et al., 1957; Goodrich, 1963; and Spear, 1965 have also failed to find evidence for reward contrast. The reasons for these and other failures to obtain contrast effects are not yet clear. Such variables as reward magnitude differences, temporal relationships (Marx, 1962), situational differences, similarity of the behavioral performance required before and after shift, and the S's motivation, have not been systematically investigated. The importance of at least the latter variable has been demonstrated by Ehrenfreund and Badia (1962), who found a contrast effect in the runway situation only under conditions of high hunger drive.

The second class of experiments may be illustrated by a study by Lauer and Carterette (1957) in which rats were repeatedly trained and extinguished on a running task for a constant quantity of reward. Of interest is the fact that following the last three of the four acquisition sessions, the animals showed significantly lower starting latencies than a control group which was run constantly without any interspersed extinction sessions. Assuming that the extinction periods represented extreme cases of lowered reward magnitude, the contrast effect found is quite consistent with the results obtained in the Collier and Marx study. Similar results were obtained in a study embodying this conceptualization by Adamson, Bevan, and Maier (1961).

A final type of study in which this phenomenon has been investigated is best exemplified by an experiment by Spear (1964). In this case, it was reasoned that if an animal's speed of approach to the less favorable alternative (LFA) of a choice situation (the smaller of two rewards) was inversely related to the magnitude of reward on the more favorable alternative (MFA), a "simultaneous contrast effect" could be said to occur. Specifically, the authors trained groups of rats on a position discrimination problem in which the correct choice (the MFA) was rewarded with more pellets than the incorrect (the LFA) choice. The LFA always had a one pellet reward while the MFA had one, two, or ten pellets. Briefly, the results indicated that, although all groups (except the one choosing from equal rewards) eventually came to prefer the side having the lager reward, the speed at which such a preference came about was directly related to the size difference between the LFA and the MFA. Perhaps more interestingly, the speed to the LFA during forced trials was inversely related to the nominal reward value of the MFA. Similar findings were obtained in studies by Goldstein and Spence (1963); Hill and Spear (1963); and Spear (1964).

In an attempt to provide a unified explanation for these phenomena, Bevan and Adamson have recently formulated a theory of reinforcement in terms of Adaptation-Level (A-L) theory.

The Bevan-Adamson Model
and Some Relevant Studies

Recognizing the considerable explanatory power of frame-of-reference psychophysics in dealing with such phenomena as anchor effects, constancy, and sensory contrast, (Helson, 1959), Bevan and Adamson (1960) reasoned that if it were permissible to assume a reinforcement analogue for the sensory adaptation-level, such phenomena as reward contrast, adaptation to repeated reinforcement, and the superiority of partial reinforcement might be subsumed under a single set of explanatory concepts. Basic to such an extension is the demonstration that reinforcing events have properties similar to those of sensory events. Three properties were deemed crucial: (a) common reinforcing stimuli should be scalable along some dimension; (b) the reinforcing value of a given stimulus would derive from its relation to some internal norm; and (c) reinforcing stimuli should pool over time.

Three experiments were performed with human _S_s to demonstrate the validity of the above assumptions. In the first experiment, _S_s were required to judge five physical intensities of shock under three conditions, using a rating scale ranging from "very-weak" through "medium" to "very strong." In the first condition each shock was presented an equal number of times; in the second and third conditions, the distributions were progressively skewed such that weaker intensities were presented more frequently. If reinforcing stimuli behaved in a manner similar to sensory stimuli, the intensity judged "medium" (the adaptation-level) would be lowered by more frequently sampling the lower intensities. This was found to be the case.

In order to test the second assumption _S_s were given pre-test experience with one of three intensities of shock, (1300 microamperes, 2300 microamperes, and 3300 microamperes) and then given training in a bolt head maze with the medium intensity shock given for incorrect responses. If the reinforcing value of the medium intensity shock derived from its relation to some internal norm, then the Ss given prior experience with the 1300 microampere current should evidence better performance with the 2300 microampere reinforcer than should the Ss who had prior experience with the 2300 microampere shock (Group B), while both should exceed the Ss experiencing the 3300 microamperes shock (Group C). The results indicate this to be the case; although all three groups were alike in performance initially, across trials Group A began to make fewer errors than Group B which in turn made fewer errors than Group C.

A similar experiment using animal Ss essentially confirmed this finding (Black, Adamson, and Bevan, 1961).

In a third experiment testing whether reinforcing stimuli pool over time establish an internal norm against which other stimuli are evaluated, Ss were given training in a complex maze in which a given incorrect response could be punished with any of five intensities of shock (1300, 1800, 2300, 2800, or 2300 microamperes. Group A received a positively skewed random distribution of shocks in which the intensities occurred from lowest to highest 31%, 25%, 22%, 14% and 7% of the time with a mean of 2000 microamperes. Group B performed with a negatively skewed distribution in which the percentages were exactly reversed from those of Group A. The mean was 2600 microamperes. Group C received a symmetrical distribution with a mean of 2300 microamperes. A control group C' was always punished with a 2300 microampere shock. Briefly, the results gave some support to the assumption that the different distributions of shock pooled to create differences in performance. Although in the latter portion of the training, groups B, C, and C' did not differ in number of errors, all were significantly different from Group A which had experienced the lowest mean intensity of shock.

With these basic conditions met, the theory was given a more quantitative formulation (Bevan and Adamson, 1962):

> (1) Reinforcing agents are stimuli (*S*) which, as do other stimuli, vary in frequency of occurrence (*n*), have temporal duration (*d*), and differ in intensity (*i*).
> (2) Upon application, *S* gives rise to stimulation processes (*s*) within the organism, these processes having the property of intensity.
> (3) The organism is selective, differentiating stimulation (*s*) into two classes: primary stimulation ($s_p$) and background stimulation ($s_b$). These processes are inferred stimulus variables, roughly corresponding to the traditional separation of figure-ground or focal and contextual stimuli.
> (4) The organism is a norm-deriving mechanism, averaging stimulation over time to effect an internal standard or referent ($\bar{s}$), defined by the following expression:

$$\bar{s} = \frac{(s_{b1} - s_{b2} - \ldots s_{bn})^x}{N_b} \frac{(s_{p1} - s_{p2} - \ldots s_{pn})^y}{N_p},$$

where the first term on the right side of the equation represents the average intensity of the background process over a series of inputs and the second term the average intensity of primary stimulation over the sequential series, and where the exponents, $\underline{x}$ and $\underline{y}$, indicate the relative contributions of $\underline{s}_b$ and $\underline{s}_p$ to the norm.

(5) The magnitude differential between $s_p$ and $\bar{\underline{s}}$ at the time ($\underline{t}$) of application of $\bar{\underline{S}}$ relates directly to the judged magnitude of $\underline{S}$, expressed as ($\underline{R}_{ji}$). This differential is represented as s, the equivalent of reinforcement magnitude as distinct from the magnitude of the reinforcing agent ($\underline{S}$). The expression ($\Delta \underline{s} = \underline{s}_p - \bar{\underline{s}}$) may be positive, negative or zero, in which respective cases $\underline{R}_{ji}$ is great, small, or medium (neutral).

(6) The occurrence of behavior presupposes an organism which is aroused or under tension. Like $\bar{\underline{s}}$, tension level ($\bar{\underline{T}}$) is regarded as having temporal continuity; it is an average which at any given moment presumably represents the actions of a multiplicity of variables, only one of which ($\Delta$ $\underline{s}$) is considered in the present formulation. Factors such as deprivation and physiological status contribute heavily to $\bar{\underline{T}}$, but our concern is currently limited to the specific effects of reinforcement upon it.

(7) The relationship between tension-level and a generic class of indices labeled response-efficiency (R.E.) is held to be curvilinear, poorer performance being associated with both high and low values of $\bar{\underline{T}}$ about an intermediate optimal level.

(8) The effectiveness of reinforcement in altering performance is held to be a function of the concurrent magnitudes of $\underline{s}$ and residual $\bar{\underline{T}}$.

Of particular concern for the present paper is the relationship between positive and negative reinforcement and the effects of their systematic interaction. Since Bevan and Adamson make no distinction between classes of qualitatively different reinforcers and the nature of their relationships to one another, it is not possible from the theory as presented to make predictions regarding the effects of such interactions on behavior. However, Bevan (1964) suggested two alternative possibilities: (a) qualitative changes in reinforcing stimuli do not alter the nature or adapted values of the operating reinforcing process, assuming that the positive and negative reinforcers have the same effective value; or (b) reinforcing agents which differ qualitatively (e.g. foot shock vs. food reward) may be ordered according to their affectivity and may interact to influence the reinforcing value of each other. If the latter case is correct, it may well be that application of an affectively opposite stimulus may enhance the reinforcing value of an operating, reinforcing stimulus.

Only two published experiments have been done specifically to test this hypothesis. In the first (Bevan, 1964), Ss were trained on a vigilance task to detect omissions of low intensity tones and, depending upon the condition, given (a) no reinforcement for correct detection, (b) positive reinforcement (money) throughout the session, (c) negative reinforcement (shock) for failures to detect the omission throughout the session, or (d) either positive or negative reinforcement for half the session and then switched to the alternative reinforcement for the second half of the session. If a qualitative contrast effect were operating, the performance of the groups on which reinforcement was changed on the latter half of the task should exceed the performance for the groups which had received the same reinforcement throughout. The results, however, indicated that the groups which experienced both classes of reinforcers were significantly better on all portions of the task than were the control Ss. Since both pairs of groups were treated alike during the first half of the experiment, this finding is puzzling. Bevan, however, argued that since the subjects were informed beforehand that a change in reinforcement conditions would occur during the course of the experiment, the anticipated change served as an additional reinforcing agent which summed with the actual reinforcement operating. This factor perhaps masked whatever contrast effect might have occurred. Indeed, inspection of his data indicated a slight divergence of second-half scores for the shift groups which may reflect a contrast effect. It was felt that if the Ss had been unaware of the forthcoming change, the effect might have been demonstrated.

In a second, very similar study, (Bevan, 1965) verbal reinforcers (reward-"right" and punishment-"wrong") were employed in lieu of money and electrical shock. In this case the S could be kept ignorant of the forthcoming change in reinforcement and it was hoped that the presumed masking encountered in the previous study would be avoided. In brief, the results clearly indicated the presence of a contrast phenomenon. On the first half of the session all punishment and reward groups were virtually alike and significantly superior to the control group, which received no reinforcement; upon change in the reinforcement conditions, the groups experiencing reward change became much superior to the groups which stayed the same.

## Statement of the Problem

The purpose of the present study was to test the generality of Bevan's (1965) findings in the context of animal learning and performance. Such an extension not only would provide strong support for the existence of qualitative reinforcement contrast, but also would allow one to employ strong negative and positive reinforcers without the S's prior knowledge. As was indicated above, the latter variable was probably a factor in the initial failure

(Bevan, 1964) to demonstrate such effects.

Specifically, the present study was designed to test the effects of foot-shock given prior to the experimental session upon lever pressing for positive intracranial stimulation during the session.[1] If a qualitative contrast effect were operating, the response rates for the brain stimulation should be greater on sessions preceded by foot-shock than on sessions in which no prior foot-shock is given. Additionally, it was decided to examine the effects of administering the prior foot-shock in situations similar to and different from that in which the animal lever pressed. Although Bevan administered the contrasting reinforcers in the same experimental situation, there is no a priori reason to assume that the contrast effect is dependent solely upon situational similarities.

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1. The use of self stimulation techniques in this study is based upon several factors: (a) the technique does not require that the animal be run under any deprivation schedule, (b) the behavior tends to be relatively stable, (c) the animal does not satiate and long term effects may thus be studied, and (d) the response rate of a given animal appears to be relatively sensitive to shifts in the reinforcing value of the electrical stimulus, i.e., reductions in the intensity of stimulation is accompanied by appropriate shifts in the response rate (see, for example, Kessey, 1963).

# CHAPTER II

## General Design

Three groups of Ss were employed in this study: Group I received prior foot-shock in a situation very similar to the lever pressing situation; Group II received the foot shock in a completely different situation; and Group III served as an independent control group which never experienced foot shock. In order to provide a baseline against which to assess the effects of the prior foot-shock, each S was given ten control sessions intersperced among ten test sessions in which the prior treatment was given. On control sessions the animal was simply brought into the experimental situation and placed in the lever pressing chamber without prior foot shock. Essentially, each S served as his own control. Groups were run as blocks of Ss with several months intervening between each of the blocks. Table I summarizes the general design. For purposes of analysis, each session of fifteen minutes duration was broken into five three-minute periods and the response rates for each period were treated statistically as independent measures.

Table I. General Design and Order of Presentation of Experimental Treatments.

| Group I | | Group II | | Group III |
|---|---|---|---|---|
| Prior Shock | No Prior Shock | Prior Shock | No Prior Shock | No Prior Shock |
| Session | | Session | | Session |
| 1 | 2 | 1 | 2 | 1 - 20 |
| 3 | 4 | 3 | 4 | |
| 5 | 7 | 5 | 7 | |
| 6 | 9 | 6 | 9 | |
| 8 | 10 | 8 | 10 | |
| 11 | 13 | 11 | 13 | |
| 12 | 14 | 12 | 14 | |
| 15 | 16 | 15 | 16 | |
| 17 | 19 | 17 | 19 | |
| 18 | 20 | 18 | 20 | |

# Method

## Subjects and Surgical Procedures

The Ss used in the experiment were albino rats, and at the time of the operation weighed 285-300 g. Throughout the experiment all Ss were housed in individual cages and received *ad lib* lab chow and water. After adaptation to the colony for a period of approximately ten days, each S was anesthetized with an intraperitoneal injection of Nembutal (supplemented by ether in cases where the animal showed signs of regaining consciousness), and stereotaxically implanted with a single bipolar stainless steel electrode of approximately .75 mm. diameter which was insulated except for the cross-section of the ends of the tips. Following insertion, the electrode was cemented to the skull with quick setting dental plastic. In all cases, the coordinates were the same--4 mm. rostral from the bregma, 1 mm. lateral, and 8 mm. deep from the surface of the skull. These coordinates were reported by Olds and Olds (1963) to give high response rates. Thirty animals were successfully implanted in this manner; twelve in Group I, ten in Group II and eight in Group III.

Following behavioral testing, all animals were sacrificed and perfused with physiological saline and 10% formalin and the brain sectioned at 80 microns and stained. Electrode placement was determined for each animal using an atlas constructed by Massopust (1961)..

Apparatus

Three major pieces of apparatus were employed in this experiment. The first, the test chamber, consisted of a rectangular compartment, 6 in. wide X 8 in. long X 10 in. high, with a grid floor and a plexiglas top. Projecting from one of the narrow walls was a lever 2 in X 1½ in. which in normal position was 1½ in. above the floor. Depression of the lever caused a measured duration of brain stimulation to be delivered to the S via two leads which were connected into the animal's electrode before each session. To receive another stimulation the S had to release the bar and press it again. A take-up device prevented the S from becoming entangled in the lead wires. The total number of lever presses was automatically recorded on a digital counter and cumulative recorder. In order to minimize distracting noises and light, the entire apparatus was enclosed in a sound deadening chamber which reduced the noise level to approximately 75% of ambient room level. Additionally, a small blower was run continuously to further standardize the test situation and to circulate fresh air within the chamber. Illumination was provided by a 14 watt light, and observations were made through a double-thickness window above the test chamber.

The second and third pieces of equipment, the shock chambers, were made as physically similar and dissimilar as possible. In the former case, the chamber was dimensionally and physically identical with the test chamber with the exception that the walls were 15 in. high and no top was used. The latter alteration was necessary as the animals tended to jump and hit the top during foot shock with sufficient force to dislodge the electrode. Additionally, a small wooden box was placed in the position usually occupied by the lever. This was done to prevent the incidental association of lever manipulation with foot shock.

The dissimilar chamber consisted of a shock grid formed from one-inch wide metal plates separated by gaps of approximately 3/8 in. and an enclosing chamber which was circular in shape and constructed of transparent plastic. The chamber rested directly upon the grid and had an inside diameter of 12 in.

In both cases, shock was delivered through the grids by an Applegate square wave stimulator, model , which was wired through a pair of Hunter timers in such a manner that shock was on for one second and then off for one second. This cycle was repeated until the S had received 50 shocks. For both experiments the current was .75 ma. Brain stimulation was provided by a Grass model SD - 5 biphasic stimulator. Two millasecond pulses were used for all Ss.

Procedure

Following a one week recovery period during which the animals were handled, each of the Ss was brought into the room and placed in the test chamber with the electrode leads connected and tested for responsiveness to brain stimulation. Responsiveness was defined as the tendency to orient or attempt to orient to the source of the stimulation. During this period the animals were shaped to the lever pressing response if it had not occurred spontaneously in the first five minutes. Shaping sessions of 15 minutes duration were given once a day for four days. During this shaping, five Ss in Group I, four Ss in Group II, and three Ss in Group III were eliminated as non-responders. Thus Group I contained seven Ss; Group II contained six Ss, and Group III contained 5 Ss. (Following completion of all testing, one S from Group I, chosen at random, was discarded in order to equate the number of Ss in Groups I and II.) For each of the remaining animals a set of stimulation parameters was determined (i.e. intensity and frequency), which seemed to yield an optimal response rate without excessive physiological disturbances (e.g. head jerking or convulsive tremors). After such a set of parameters had been determined for each S and the experimenter was convinced that the animal had learned to press the lever (i.e., the S showed consistent attempts to manipulate the lever), each of the Ss was given six days of training in order to stabilize the response rate.

Following the six days of pre-training the twenty-session experimental sequence was begun. Throughout the sequence, the following regimen was observed. The subject was brought into the fully illuminated room in his home cage and placed in the holding tray for one minute. At the end of this time, (depending upon the experimental treatment that session) the S was either placed into the test chamber and connected to the stimulating wires and recording begun, or was placed into the appropriate shock chamber. Group I was shocked under subdued illumination provided by a single 15 watt bulb immediately above the chamber, while Group II was shocked in full room illumination. Control Ss in Group III were always brought into the room and placed in the holding cage for one minute before being placed in the test chamber. Following this experimental treatment, the S was replaced in the holding cage for another minute and then placed into the test apparatus. In order to eliminate as much inter-subject variation as possible, the S was always placed in the test chamber with his forepaws depressing the bar. In this manner each S always received one initial stimulation. Interval timing and recording was begun at this point. At the end of the session, the recording apparatus was disconnected and the S was removed as quickly as possible; in no case was the subject intentionally allowed to press the bar and not receive a brain stimulation. If, during the course of the session, the electrode connector pulled out, the recording devices were turned off and the S reconnected as quickly as possible. In such an instance, the S was placed in the chamber facing, but not touching the lever and recording was resumed.

# CHAPTER III

## Results

Tables 2 and 3 summarize the data obtained from Groups I, II and III. Simultaneous analysis of variance of the raw data from Groups I and II (Table 4) yielded four significant effects: Shock vs. No-Shcok (Treatment), Three-minute periods (Periods), Treatment by Periods, and Sessions within Treatments. Situational differences (Situation) were not significant nor did they interact with any other variable; consequently the data obtained from the two situational conditions were pooled. Figure 1 presents graphically the pooled effects of treatment across three-minute periods broken down into five-day blocks of shock and no shock. Figure 2 represents the effects of treatment across blocks of sessions. Additionally, the corresponding values for data from Group III have also been plotted in both cases. Inspection of Figure 1 indicates that the shock trials and the non-shock trials for Groups I and II differ during the early portion of each session, with the non-shock condition gradually increasing across three-minute periods to the same level as the experimental sessions. Statistical confirmation of this observation derives from the

Table 2. Experimental and Control Response Rates for Three-Minute Periods.

| Experimental Group | | Three-Minute Periods | | | | |
|---|---|---|---|---|---|---|
| | | 1st | 2d | 3d | 4th | 5th |
| I. | Shock Sessions | 96.4 | 95.9 | 110.1 | 96.7 | 104.5 |
| | Control Sessions | 51.5 | 72.3 | 95.7 | 94.2 | 100.5 |
| II. | Shock Sessions | 109.6 | 106.0 | 108.2 | 102.3 | 111.4 |
| | Control Sessions | 80.8 | 91.1 | 98.4 | 107.8 | 112.2 |
| III. | | 26.6 | 30.8 | 34.3 | 34.6 | 30.3 |

Table 3. Experimental and Control Response Rates Across Sessions.

| Experimental Group | | Sessions | | | | |
|---|---|---|---|---|---|---|
| | | 1-2 | 3-4 | 5-6 | 7-8 | 9-10 |
| I. | Shock Sessions | 321 | 507 | 564 | 591 | 525 |
| | Control Sessions | 370 | 312 | 417 | 468 | 451 |
| II. | Shock Sessions | 453 | 460 | 515 | 598 | 661 |
| | Control Sessions | 380 | 478 | 482 | 492 | 626 |
| III. | | 247 | 183 | 197 | 94 | 63 |

Table 4. Combined Analysis of Variance for Groups I and II.

| Treatment | df | SS | MS | F |
|---|---|---|---|---|
| Situation | 1 | 36,280 | 36,280 | <1.0 |
| Ss/Situation | 10 | 1,941,120 | 194,112 | |
| Treatment | 1 | 55,740 | 55,740 | 4.79* |
| Treatment X Situation | 1 | 5,350 | 5,350 | <1.0 |
| Ss/Situation X Treatment | 10 | 116,380 | 11,638 | |
| Periods | 4 | 80,910 | 20,227 | 3.85** |
| Situation X Periods | 4 | 14,060 | 3,515 | <1.0 |
| Ss/Situation X Periods | 40 | 209,900 | 5,248 | |
| Treatment X Periods | 4 | 56,650 | 14,163 | 19.44*** |
| Situation X Treatment X Periods | 4 | 1,130 | 328 | <1.0 |
| Ss/Situation X Treatment X Periods | 40 | 29,140 | 729 | |
| Sessions/Treatment | 18 | 394,250 | 21,903 | 1.47* |
| Sessions/Treatment X Situation | 18 | 112,503 | 6,250 | <1.0 |
| Ss X Sessions/Treatments | 193 | 2,953,907 | 14,919 | |

*p < .05 - .07

**p < .01

***p < .001

Figure 1. Pooled Experimental and Control Rates for Three-Minute Periods

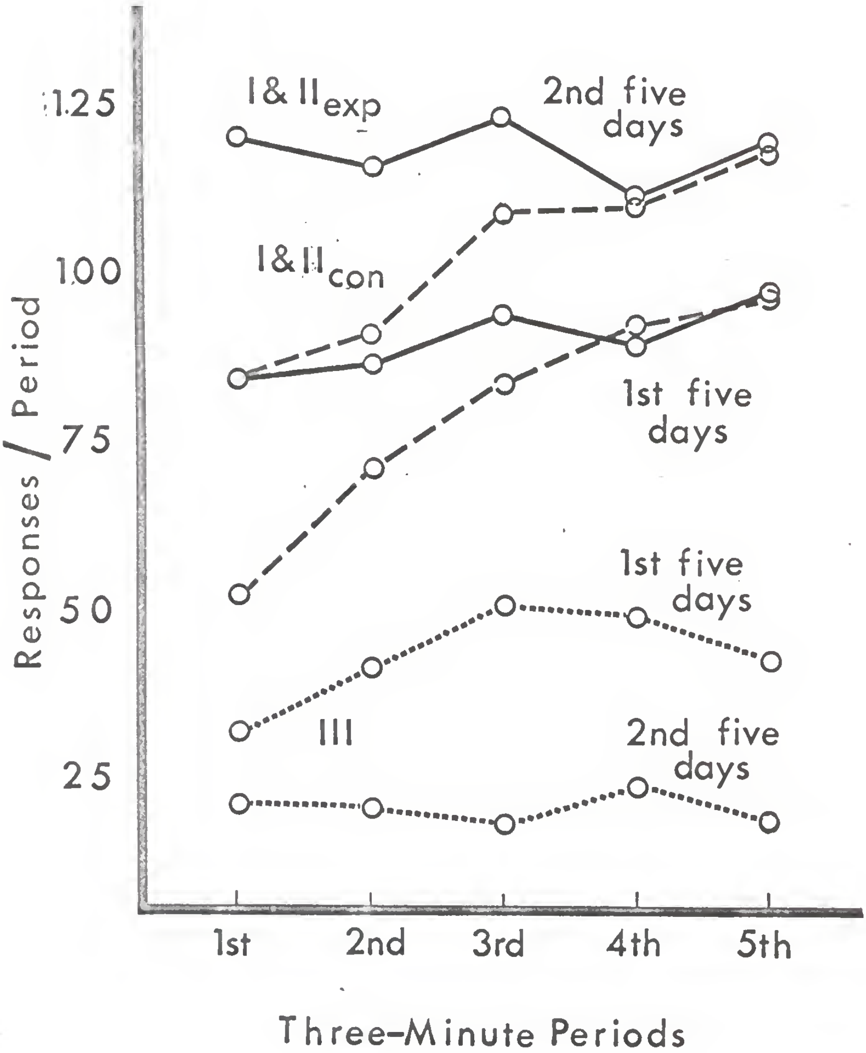
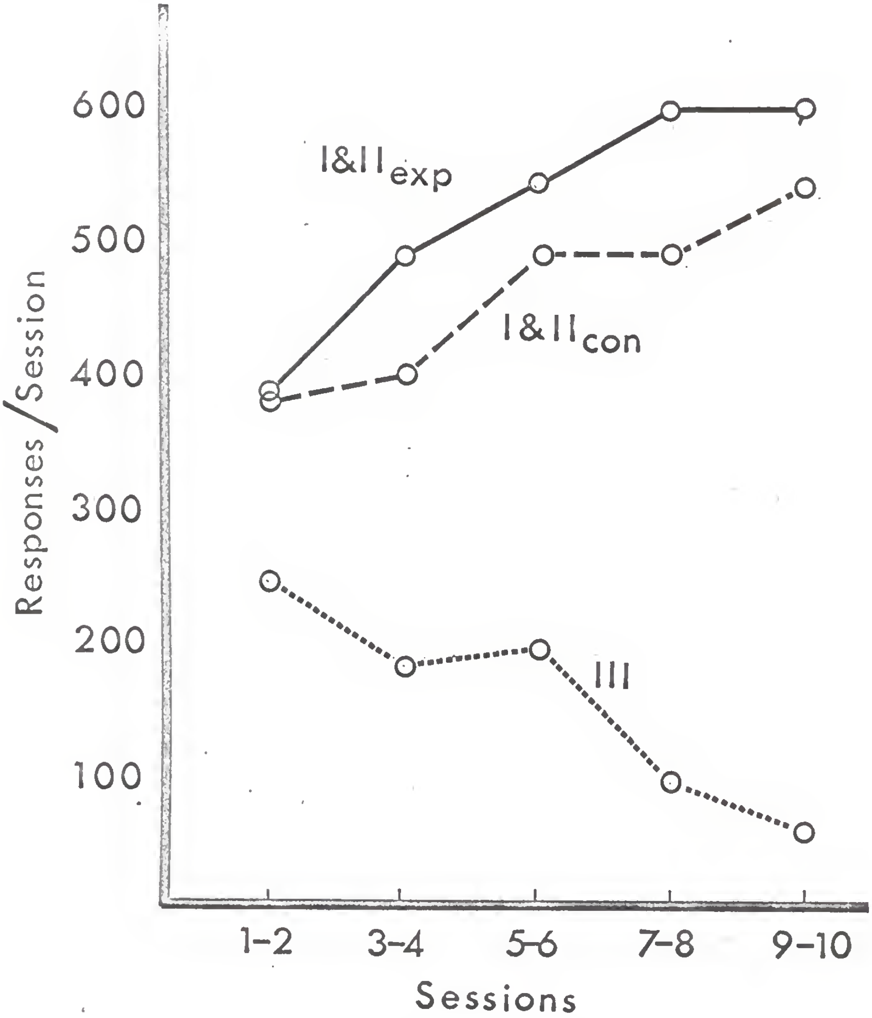


Figure 2. Pooled Experimental and Control Rates Across Sessions



highly significant interaction of Treatments with Periods.

The data obtained from Group III indicate clearly two facts: (a) the shape of the curve for the independent control condition is similar in shape to that for the non-shock trials for Groups I and II for the first five-day block of sessions though not for the second block of sessions; and (b) the Group III lever-pressing rates are considerably lower than either the shock or non-shock trials of Groups I and II.

Figure II indicates the change in rates across sessions for the shock trials and non-shock trials of Groups I and II and the control data from Group III. Although it is clear that response rates increase for both the Shock and non-shock trials, the non-consecutive nature of each of the two curves makes it difficult to discuss possible interactions between treatment and sessions. Nevertheless, it would seem that the experimental treatment is as effective (or more so) at the end of the experimental sequence as at the beginning. With regard to the independent control condition, it is clear that the response rates show marked decreases across sessions and at no point reach the rates evidenced by the animals in the other conditions.

# CHAPTER IV

## Discussion

The results obtained suggest three general findings: (a) the enhancement effect deriving from prior experience with an affectively opposite reinforcing stimulus is apparently not dependent upon situational similarities; (b) such an effect manifests itself early in the experimental session by bringing the S to maximal performance immediately; and (c) the experimental treatment evidently acts in some cummulative manner across sessions to gradually increase the response rates of the Ss.

### Situational Variables

To consider the first point in more detail, that the enhancing effect of the foot shock occurred when the S was shocked in either the same or different situation suggests that the contrast phenomenon is neither response nor behaviorally contingent. That is, the perceptual changes which occur were not governed by situational variables *per se*. Conceivably, however, reinforcement contrast may be dependent upon other factors such as the nature of the sensory modalities stimulated for its operation.

The lack of dependence of the contrast effect upon situational differences also suggests two possible alternative explanations for the response enhancement. First, instead of assuming that the prior foot shock altered the S's adapted level (AL) for a given reinforcing agent, it might be argued that the treatment simply agitated the S to the point that, when he was introduced into the test chamber, his heightened activity increased the response rate. Two factors militate against this interpretation, however. First, the one-minute delay period between experimental treatment and testing should have eliminated gross bodily agitation. Secondly, observation of all Ss failed to yield evidence for such an interpretation; all heightened behavioral activity observed was directed at the lever specifically and random activity accounted for very few of the responses recorded.

The second alternative explanation is somewhat more plausable. It has been suggested by some (e.g. Howarth and Deutsch, 1963) that the drive state associated with brain stimulation may be altered by changes in other motivational states, i.e., drive states may pool to produce stronger motivation to obtain brain stimulation. Such explanations have been offered to account for the finding that with certain electrode placements, food or water deprivation may increase response rates for a consistent quantity of brain stimulation (Olds, 1958). It should be noted that Bevan and Adamson's formulation likewise suggests that such pooling may take place. If it is assumed that $\overline{T}$ (tension level) is increased by the application of foot shock, it could function to enhance the S's performance for the brain stimulation.

This type of interpretation has two difficulties however: evidence for drive-inductive increases in responding for intracranial stimulation is controversial and some investigators have failed to find evidence for the phenomenon (e.g. Herberg, 1963); secondly the defining operations for the concept of motivational pooling are difficult to distinguish from those of reinforcement pooling. Thus, not only is a drive (fear) being generated by foot shock but the animal is being negatively reinforced, or perhaps more accurately, punished. In the context of this experiment then, the second of the alternative explanations adds little to the understanding of the observed phenomena. Since evidence for the operation of reinforcement contrast seems at this time to be more compelling than that of motivational pooling, we will, for purposes of this paper, continue to evaluate our results in terms of the former concept. It should be borne in mind, however, that quite possibly both factors could be operating.

Effects of Prior Foot-Shock Within Sessions

Considering now the within-session effects, two findings are of considerable interest. First, the contrast effect is apparently strongest at the beginning of each experimental session and serves to bring the S's response rate up to some maximal level which is maintained thereafter. The failure of the rate to appreciably exceed asymptotic level for the control condition may be due to either a ceiling effect of the stimulation parameters used or a failure to employ stronger foot-shock. Very possibly both factors were operating.

A second finding of considerable interest is the fact that both the shock and non-shock trial rates are markedly higher than those of the independent control data. This suggests that the foot-shock exerts an effect not only upon the experimental sessions but also in some way upon the non-shock sessions.

It is conceivable that such an effect may reflect--in a manner analogous to secondary reinforcement--the development of associations between the foot-shock and the procedures and apparatus common to both experimental and control sessions. Thus, previously neutral objects may become capable of eliciting the same contrast effect as the foot-shock itself. Such an interpretation is supported by the findings regarding the effect of foot-shock on response rates across sessions.

<u>Effects of Prior Foot-Shock Across Sessions</u>

When the results of the experimental treatments are viewed across sessions, it is clear that the contrast effect is equally strong at the end of the sequence as at the beginning. Of perhaps greater interest is the significant rate increase across sessions of the shock and non-shock trials of Groups I and II as compared with the independent control condition. Such an increase suggests that either the experimental treatment summates temporarily across sessions or, as was suggested above, transfers its affective contrast to formerly neutral surroundings. The former possibility seems unlikely in light of the fact that the sequence for each <u>S</u> was twenty days long. However, if it is assumed that each experience with the foot-shock increases the power of associated surroundings to elicit the contrast effect, the gradual increase in response rates across sessions for both the shock and non-shock trials becomes explicable.

Two factors thus would seem to operate in the production of the experimental contrast effect: (a) the foot-shock given immediately before the session; and (b) the affectively charged surroundings and operations. In light of the fact that the within-session curves are similar in shape at the beginning and end of the experimental sequence (i.e. simply shifted upward on the Y-axis), the latter factor would seem to have its effect primarily upon the asymptotic rate for the particular session involved while the foot-shock itself altered the rate at which this level was reached.

Summary and Conclusions

The purpose of the present study was to test an hypothesis derived from the Bevan-Adamson model of reinforcement that the application of an affectively opposite reinforcer (foot-shock) immediately before the S is allowed to respond for positive intracranial stimulation would enhance the rate of responding over control sessions in which no prior treatment was given. The effect of giving the foot-shock in situations similar to and different from the lever-pressing situation was also examined in an effort to establish the role of this variable in the hypothesized contrast phenomenon.

Eighteen male albino rats served as Ss. Each had a single bipolar electrode implanted in an established positively reinforcing site and was assigned to one of three conditions: Group I which was given foot-shock in a chamber identical to that of the lever-pressing situation; Group II which was given the shock in a completely different chamber, and Group III, an independent control group which never experienced foot-shock. Each experimental S served as his own control and received ten experimental sessions interspersed with ten control sessions in which no prior foot-shock was given.

It was found that (a) the experimental

treatment enhanced the rate of responding during the early portion of each experimental session over that of the corresponding sessions; (b) the treatment evidently acted across sessions to increase the rates of both the shock and non-shock sessions of Groups I and II over that of the independent control group; and (c) situational variables as investigated were irrelevant to the occurrence of the qualitative contrast effect.

The above results suggested the operation of two factors; (a) the direct action of foot-shock upon the immediately subsequent test situation; and (b) the transference of the negative affect of the foot-shock to the experimental surroundings. The latter apparently operated to increase the effective asymptotic rate of responding across sessions for both the shock and non-shock sessions of the experimental groups, as opposed to the decreasing rates for the independent control group.

The findings of the present study are taken as confirmation for the existance of qualitative reinforcement contrast effects and essentially confirm the results of Bevan's previous work with human _S_s.

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# THE EFFECTS OF PRIOR FOOT SHOCK
# UPON BAR PRESSING FOR INTRACRANIAL STIMULATION

by

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B. S., Highlands University, 1964

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AN ABSTRACT OF A THESIS

submitted in partial fulfillment of the

requirements for the degree

MASTER OF SCIENCE

Department of Psychology

KANSAS STATE UNIVERSITY
Manhattan, Kansas

1966

The purpose of the present study was to test an hypothesis derived from the Bevan-Adamson model of reinforcement that the application of an affectively opposite reinforcer (foot-shock) immediately before the S is allowed to respond for positive intra-cranial stimulation would enhance the rate of responding over control sessions in which no prior treatment was given. The effect of giving the foot-shock in situations similar to and different from the lever-pressing situation was also examined in an effort to establish the role of this variable in the hypothesized contrast phenomenon.

Eighteen male albino rats served as Ss. Each had a single bipolar electrode implanted in an established positively reinforcing site and was assigned to one of three conditions: Group I which was given foot-shock in a chamber identical to that of the lever-pressing situation; Group II which was given the shock in a completely different chamber, and Group III, an independent control group which never experienced foot-shock. Each experimental S served as his own control and received ten experimental sessions interspersed with ten control sessions in which no prior foot-shock was given.

It was found that (a) the experimental

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