The Postural Factors in Shock-Shock Conditioning

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Introduction. Recent investigation in the field of conditioning has tended in the direction of a more precise control and a more subtle analysis of the conditioned response situation representing many attacks on special problems from various lines of approach. Perhaps foremost among the methods employed have been those utilizing specially designed apparatus for the study of motor responses (**1**, **3**, **6**), action potential techniques, and surgery (**9**). Another line of study has employed drugs of both excitatory and depressant nature (**5**, **8**, **11**, **14**), and has yielded rather contradictory results. The latter method would seem to recommend itself as being superior to extirpation since one can inactivate, excite, or depress behavior of animals to a desired degree through well-standardized doses and still maintain the animal in an intact condition for future retention and other tests.

Utilizing such a method, Headlee and Kellogg (**8**) at the Indiana University Laboratory in 1940 investigated the rate of conditioning of dogs injected with the depressant drug, Nembutal. Using a refined flexion conditioning technique, they found that conditioning proceeded at a greatly retarded rate under drug as compared with non-drug training. These investigators were able to keep the unconditioned stimulus (shock) constant in accordance with a behavioral criterion, namely a four-inch flexion. But they are rightfully skeptical about the "constancy" of the conditioned stimulus which was *fixed* at 50 db. above the human threshold. The present investigation was in part carried out as a check on their findings.

More pertinent to the present study, however, are the results of certain experiments on postural variables in conditioning. For example, Yoshioka (**16**), in studying handedness in rats, concluded that laterality may introduce an uncontrolled factor which may influence behavior at a choice point. In other words, if a rat has a sidedness preference, some mazes will be unusually difficult for him.

An accidental finding of Brundage's (**2**) at the Indiana Conditioning Laboratory disclosed the unusual fact that, in general, the reflex response that was being conditioned (in the rear foot) also involved the response of the front foot on the opposite side more often than that of the same side. There seemed to be a hint here of a hitherto unexplored functional linkage between the diagonally opposite feet. This result stimulated the present study.

Pertinent also is the observation of Kellogg, Scott, Davis and Wolf (**10**) that the flexion CR in dogs is a complex response and that the shifting of weight and postural readjustments, moreover, may take in a good deal of the skeletal musculature of the forepart of the body. More recent work by Davis (**4**) on "Set and Muscular Tension" investigated

by means of action potentials suggests that there may be a variety of tension patterns distributed in a particular "set." While Davis' research was restricted to human subjects, it has certain implications for animal work.

In a summary way, then, the few studies reviewed establish the fact that the way conditioning shall develop in a particular organism depends, in a measure, upon the immediate and past postural conditions.

A thorough search of the literature reveals the curious fact of only three instances in which both conditioned and unconditioned stimuli employed have been in the same sense department. It would seem that if both CS and US are the same, they may be more objectively measured and controlled. At the same time, they permit a simplification, as it were, of the experimental situation. At any rate, their use permits a more careful analysis of conditioned and unconditioned responses. Unquestionable, too, is the advantage of a direct comparison of the conditioned and the unconditioned response. In view of the feasibility of investigations from such an approach, it is indeed strange that practically all research has regularly involved two different sense modalities.

Statement of the Problem. The foregoing account of conditioning literature suggests that drug effects are not well understood, that the work has just begun to yield information and that it is sometimes contradictory. Except where refined methods have been ingeniously devised for highly specific study, all the experimental factors have not always been under control. A review of the literature, likewise, discloses a rare occurrence of conditioning methods employing stimuli in the same sense modality. The two or three studies mentioned above have yielded information strikingly different from that usually derived. Such a technique may be justifiably investigated *per se* for comparison with traditional methods.

The present experiment proposed, then, to investigate more precisely the postural variables noted by previous investigators. The plan was to train two groups of four dogs each in the following manner. One group would receive a conditioned stimulus shock in the right front and the other group in the left front paw. By use of the readily available shock-shock technique it would be possible to deliver an unconditioned stimulus shock to the right rear feet of all subjects. That is, the Ss would be conditioned to lift the right rear paw to a conditioned stimulus shock in the front limb. In this way, both stimuli would be the same and their responses would then be comparable. Best of all, responses to the two shock stimuli would be directly observable and no guess work would be necessary regarding its "effect." A behavioral criterion of a prescribed lift of the shocked feet could be elicited and maintained by means of an adjustable stimulus.

Such a set up warranted, as a purely incidental project, use of Nembutal as a means of furnishing a check on the effectiveness of the buzz-shock technique employed by Headlee and Kellogg (8) in their conditioning with Nembutal.

The problem, therefore, resolved itself into a four-fold investigation which aimed specifically:

1. To investigate the possibilities of the shock-shock technique for conditioning.

2. To note what effect differential postural adjustments have on rate of acquisition of the conditioned response.

3. To probe into the general nature of conditioning within the same sense modality.

4. To check on the validity of the buzz-shock method in conditioning under Nembutal.

Experimental Procedure. The experiment, conducted at the Indiana University Conditioning Laboratory, utilized eight unselected mongrel dogs supplied by an animal dealer. The procedure was to place each subject individually in a conditioning stock located in a sound-proof room with one-way vision windows. Each foot of the S was fastened to a lever which permitted the recording of foot movements upon a smoked kymograph record. Record was also made of the time of presentation of both stimuli, breathing changes, and a time line.

Such a method of stimuli presentation has been called the shock-shock technique and has consisted simply of substituting an additional electric shock for the customary buzz of the buzz-shock method without changing the unconditioned stimulus or the duration or spacing of either stimulus. The conditioned stimulus shock has consisted of a 1,000-alternating current shock of 2 sec. duration delivered to one of the forepaws. The unconditioned stimulus consisted of the usual make-break direct current shock .2 sec. in length occurring simultaneously with the last .2 sec. of the conditioned alternating-current shock. In the case of four subjects, designated the homolateral group, the conditioned shock was sent to the right front paw and the unconditioned stimulus to the right rear limb (i.e., the same side). In the case of subjects of the diagonal group, the conditioned shock was delivered to the left front paw and the unconditioned stimulus to the right rear (i.e., the diagonally opposite foot). Other features of the procedure have been published elsewhere (**8, 9, 10**).

Training was carried out in the following manner. Each S was given a total of 400 trials, distributed in four sessions of 100 trials each spaced a week apart. Half of the trials were made under drug and the other half under non-drug (control) conditions. Four of the subjects received hypnotic doses of Nembutal in the first and third sessions and the other four in the second and fourth. This rotational plan minimized effects of order within the conditioning process. Tests of retention of the conditioned response were made prior to any training and previous to the weekly series of each succeeding session of 100 trials. Measures of frequency, amplitude, and latency of conditioned response were tabulated from which learning curves were drawn and analyzed for each S and for the two groups (homolateral and diagonal). Behavioral notes yielded data with respect to struggling, defecation and urination.

Summary of Results. The primary finding of the present experiment was that diagonally trained Ss (i.e., those stimulated in the left front and right rear feet) were more easily conditioned to make a

flexion response than were homolaterally-trained Ss (right rear and right front paws). Figure 1 readily indicates the erratic course of CR acquisition of the homolateral group as compared with the more steady rise of the curve for the diagonals. This is interpreted as being the result of contradictory responses initiated in the limbs of the homolateral

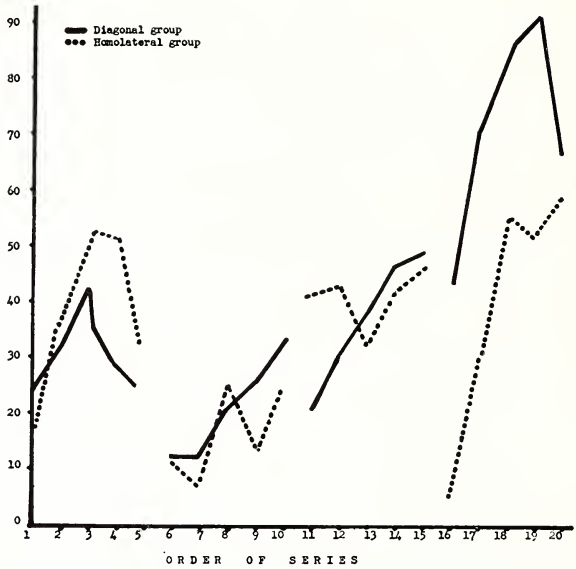

Fig. 1. Percentage frequency of conditioned responses in right rear leg of diagonal and homolateral subjects.

Ss and is in line with the Sherrington (12) claim of a functional linkage of diagonally-opposite members. In other words, the diagonally-trained dogs were administered a type of stimulation which we might consider as more "natural." It involved an easy readjustment of posture to lift diagonally opposite feet. On the other hand, the homolateral group which received stimulation entirely on one side (right rear and right front feet) had a more difficult time in acquiring the CR because of the greater disturbance and also because a facile postural readjustment in their case was prevented. Such conflicting movements have actually been observed in the protocols.

Further evidence of more favorable conditioning in the homolateral group is seen in figure 2. This shows results obtained in the retention tests given prior to training and previous to each subsequent session in which the unconditioned stimulus shock was omitted and the conditioned stimulus shock to the front foot was given alone. It will be noted that both groups show an identical start of 10% prior to any training. This is interpreted to be the result of a generalized struggle response characteristic of early training in all animals. But note the divergent results in succeeding tests. The diagonals gradually rise to a high of 37.5%

while the homolateral S decline to a low of 2.5%, again indicating more favorable conditions of the diagonal Ss.

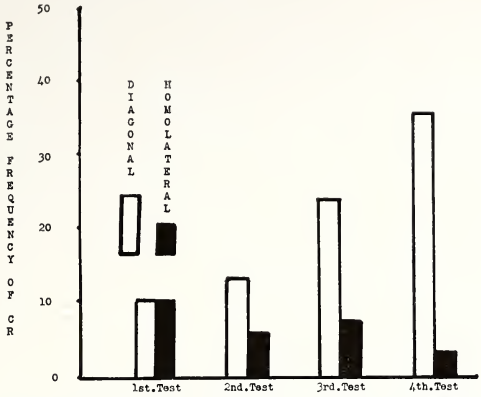

Fig. 2. Average retention of conditioned responses of right rear leg of diagonal and homolateral groups. Each retention test was given prior to any training and immediately preceding the four successive-sessions spaced a week apart.

Furthermore, it was found that there were twelve instances of urination and defecation in the homolateral Ss but only one such occurrence in the case of the homolaterals. It has been suggested by some investigators that such behavior results in emotional, disorganizing situations and may well reflect the more favorable experimental situation of the diagonally-trained group of animals.

As to drug differences, it was incidentally noted that both groups showed better conditioning under non-drug than under drug conditions. In addition, when percentage frequency curves of acquisition were drawn and compared with those drawn for the six Ss in the buzz-shock investigation of Headlee and Kellogg (8), it was found that:

(1). Rate of CR acquisition for the Diagonally trained group was superior to that of their Ss.

(2). Homolaterally trained Ss were somewhat less efficient in this respect.

(3). Under "favorable" circumstances, the shock-shock technique is superior to buzz-shock conditioning.

Summary and Conclusions. Eight unselected mongrel dogs were conditioned by means of the shock-shock technique, a method employing shock stimuli for both the conditioned and unconditioned stimuli. Four of the subjects (the homolateral group) were trained to lift the right rear foot to a shock in the *right front* paw and the other four (diagonal group) to a shock in the left front limb; i.e., the diagonals received an unconditioned shock in the right rear foot and a conditioned stimulus shock in the left front, the diagonally-opposite paw, and the homolaterals were given an unconditioned stimulus shock in the right front. Four sessions, each consisting of one hundred trials spaced a week apart and alternating drug with non-drug sessions were given each subject.

Tests of retention were made previous to the weekly series of 100 trials. Kymograph record was also made of respiration and of the lift of each foot. Measures of frequency were tabulated and analyzed and behavioral data scrutinized for significant observations.

Results showed that diagonally-trained Ss showed a more gradual and consistent acquisition of conditioned response than homolaterally-trained animals as a result of more favorable stimulating circumstances of the former group. Further proof of the superior conditionability of the diagonal Ss was evidenced in the retention tests administered both groups weekly and in the lack of evacuations and defecations for these Ss. However, both groups showed better performance under non-drug (control) than under drug conditions. As to the relative merits of shock-shock and buzz-shock conditioning, it was found that a higher level of efficiency was secured for our diagonal group as compared with Headlee and Kellogg's subjects trained by the buzz-shock method and that even our homolateral (unfavorably trained) animals are not greatly inferior. The shock-shock method is believed to recommend itself as an invaluable procedure for precise work, particularly with use of drugs, where thresholds are far from stable.

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