THE OPERANT CONTROL OF VOCALIZATION IN THE DOG[1]

KURT SALZINGER, BIOMETRICS RESEARCH AND COLUMBIA UNIVERSITY

AND

MARCUS B. WALLER, ROSCOE B. JACKSON MEMORIAL LABORATORY[2]

Control over the vocal responses of three dogs was established using operant-conditioning procedures. Several points of interest were observed in the data. First, fixed-ratio schedules of reinforcement generated a vocal response topography which was similar in detail to that of a "motor" bar-nosing response. Second, vocal responding was brought under the control of external visual stimuli as a result of differential reinforcement. Third, good stimulus control was maintained on a multiple schedule containing a vocal-response component and a bar-response component. Fourth, the stimulus control on the multiple schedule transferred with minimal disruption to a chain schedule requiring a sequence of 10 bar responses followed by 10 vocal responses. Fifth, because vocal and bar responses are not mutually exclusive, concurrent responding tended to develop on the chain schedule.

These results were discussed with reference to the advisability of applying the terms operant and respondent to unconditioned behavior, and, particularly, to unconditioned verbal behavior.

Recently, many investigators (Krasner, 1958; Salzinger, 1959) have studied verbal behavior in the human being, using the operant-conditioning paradigm. This model is based almost exclusively upon work with animal nonverbal (or nonvocal) responses like the bar press in rats (e.g., Skinner, 1938) and the key peck in pigeons (e.g., Ferster & Skinner, 1957). Moreover, it ignores a possible major difference between verbal and nonverbal behavior: Verbal (vocal) behavior does not usually have an obvious effect upon the inanimate environment, whereas nonverbal behavior generally does. This raises the question of whether verbal and nonverbal operant conditioning can be assumed to take the same course, i.e., be controlled by the same variables and in the same way.

Skinner (1957) and Thompson (1958) imply that animal vocalizations like barking are emotional in character, i.e., respondents, and

so are not sensitive to operant-conditioning procedures. Ginsburg (1960) and Lane (1960, 1961), on the other hand, showed that operant-conditioning procedures can be applied to the vocalizations of the shell parakeet (Budgerigar) and Bantam chicken, respectively. Also, Konorski (1948) mentioned, without giving details of his procedure, that a dog was trained to bark.

More recently, Lawicka (1957) described the operant conditioning of barking in three dogs using discriminative stimuli of very short duration (1½ to 5 sec) and the latency of the first response as the dependent variable.

In this study, we attempted to subject the barking response to operant-conditioning procedures, and to compare its discriminative control with that of a nonvocal response. Specifically, the procedures entailed increasing its rate of occurrence by fixed-ratio reinforcement schedules; bringing the response under the control of discriminative stimuli; and, finally, using it in a chaining procedure.

METHOD

Subjects

The subjects were three male dogs. One was a 3-year-old, wirehaired fox terrier (WHT), and the other two were 1½-year-old, purebred beagles (Beagle 1 and Beagle 2).

Before this experiment, Subject WHT had had an experimental history of nosing a bar for food on various schedules of reinforcement. Beagles 1 and 2 had been used in an experiment on the effects of social isolation on puppies. This experiment terminated approximately 1 year before they were used here.

Apparatus

The experimental chamber consisted of a sound-deadened enclosure placed in a larger room which was isolated from the sounds of the rest of the laboratory and from the kennels. The enclosure contained a ventilating fan, a light fixture with a 100-watt bulb, a water pail, a microphone, and a food dish which was connected to an automatic feeder. In later portions of the experiment, a nose manipulandum (Waller, 1960) was attached to the same wall of the enclosure as the microphone and the food pan.

Except for an initial period when *E* monitored vocal responses and reinforced by a hand switch, all recording and programming was done automatically from an adjacent room. Vocal responses were picked up by a microphone, the output of which was led through a tape-recording monitor and through an amplifying circuit to operate a sensitive relay. The contacts of the sensitive relay were then used to operate the recording and control apparatus.

Procedure

Subjects were reduced to approximately 80% of their free-feeding weights by the complete withdrawal of food. After several days of deprivation, two of the subjects (Beagle 1 and Beagle 2), which were naive about the present experimental conditions, were confined in an enclosure for alternate 24-hr periods. After several (four to six) such exposures to the enclosure, these *Ss* were sufficiently habituated to the situation and were readily feeder-trained. (The habituation and feeder training were unnecessary for Subject WHT, because he had had an extensive history of nosing a bar for food in a similar situation.) Response-differentiation training was then instituted: *E* monitored the vocal responses and reinforced discrete barks by hand. Because Beagle 1 and Beagle 2 tended to vocalize spontaneously in the situation, response differentiation proceeded smoothly, each bark being reinforced by a 2-to 3-g pellet of Big Red Dog Chow. Barks were extremely improbable behavioral events for WHT, however; and a special procedure was therefore used to increase the probability of this subject's barking. The *E* sat beside the enclosure and emitted bark-like sounds. Resultant barks by WHT were immediately reinforced, initially on a CRF schedule and later on small fixed-ratio schedules (FR 2, 3, and 4). After several sessions on this procedure, WHT responded readily in the absence of *E*'s bark-like sounds.

At this point, all *Ss* were placed on a schedule of continuous reinforcement which was programmed through the voice-key arrangement described above. Subsequent changes in the schedules of reinforcement and the stimulus conditions within the enclosure will be described at the appropriate places in Results.

RESULTS

Figure 1 shows cumulative records of the vocal responding of all *Ss* on fixed-ratio schedules of reinforcement. Portions of records for
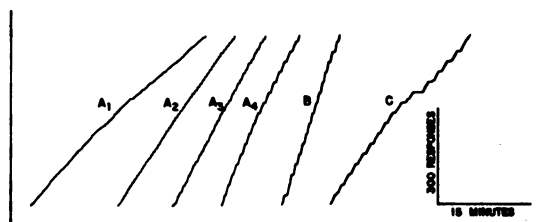

Fig. 1. Cumulative records of all *Ss* on fixed-ratio schedules of reinforcement. For explanation see text.

Beagle 1 are labeled A_1 (FR 3), A_2 (FR 11), A_3 (FR 11-FR 22 alternating), and A_4 (FR 33). These records represent final stable performances at the parameter values indicated. The apparent increases in rate (slope) is primarily a function of the lower density of reinforcements, *i.e.*, less time spent eating, as the ratio increases. Record B in Fig. 1 shows the final performance of WHT on FR 33, and Record C shows the final performance of Beagle 2 on FR 33. It is interesting to note that Beagle 1 and Subject WHT held a ratio of this magnitude with minimal strain. Beagle 2 showed considerably more strain on FR 33 than on smaller values of the ratio (records not shown). Reinforcements are not marked on this figure, but are seen as lines with zero slope.
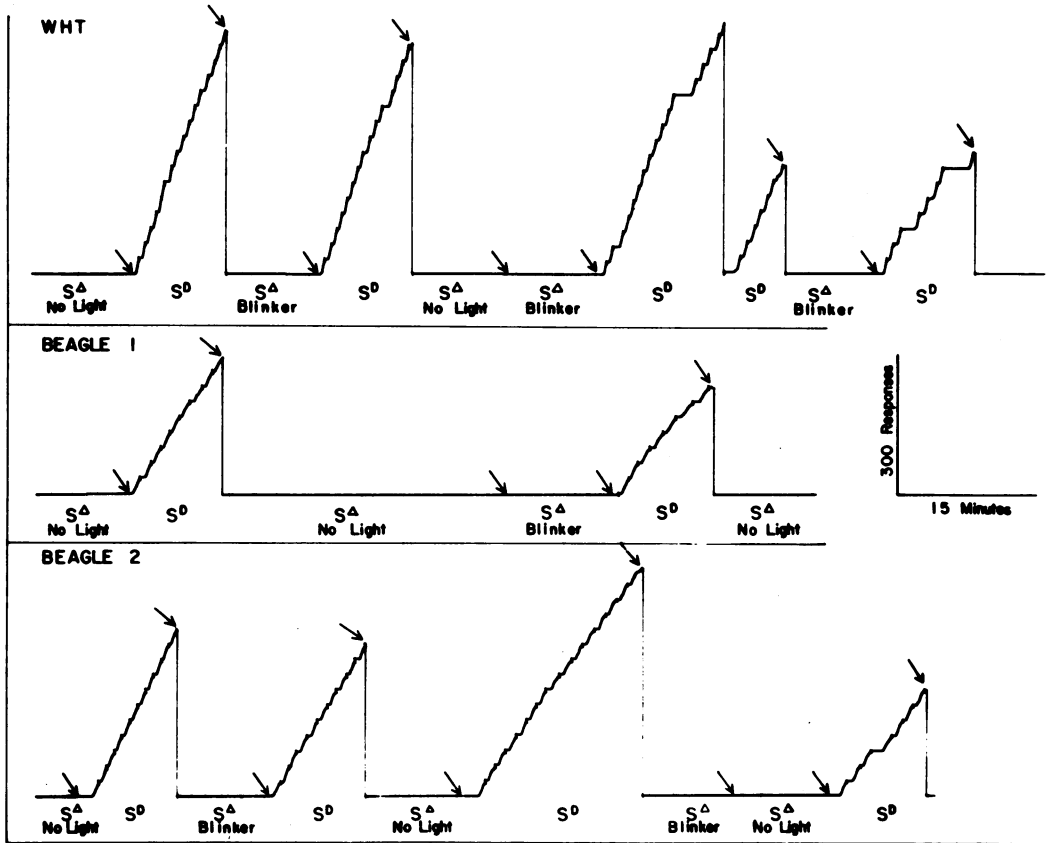
Fig. 2. Cumulative records of the final performance of all *S*s after discrimination training. For explanation see text.

Figure 2 shows the complete cumulative records of the final performances (after approximately 20 sessions) of all *S*s following discrimination training. Two stimulus conditions were correlated with nonreinforcement: no light and blinker or flashing light produced by a 100-watt bulb flashing at 1 cps. Continuous illumination by a 100-watt bulb was correlated with reinforcement of vocal responding. The arrows in Fig. 2 indicate a change in stimulus conditions. The records show that vocal responding is readily controlled by discriminative stimuli which have been correlated with differential histories of reinforcement. After a change to the S^D condition, all *S*s tended to have an initial delay before the first response was emitted.

At this point in the experiment, an attempt was made to establish a multiple-response repertoire in the *S*s and to bring each response under the control of a different discriminative stimulus. This resulted in a multiple schedule of reinforcement in which vocal responses

were reinforced on an FR 33 schedule during the "Light On" stimulus condition; bar-nosing responses were reinforced on an FR 33 schedule during the "No light" stimulus condition; and both responses were on an extinction schedule during the blinking-light stimulus condition.

Because WHT had had a prior history of bar responding, no shaping was required to establish the bar-nosing response for this subject. Following a brief period on a CRF schedule for bar nosing, WHT was placed on the final multiple schedule without going through lower FR schedules, *i.e.*, mult FR 33_{vocal} $S^\triangle$ vocal and bar FR 33_{bar}. Beagle 1 was shaped spontaneously by being left in the S^D_{bar} condition overnight for several days with the schedule value CRF. When responding began, the schedule was gradually changed to FR 33, the final value. An attempt was made to shape Beagle 2 spontaneously, but without success. Because the box was dark, a shaping procedure of successive approxima-
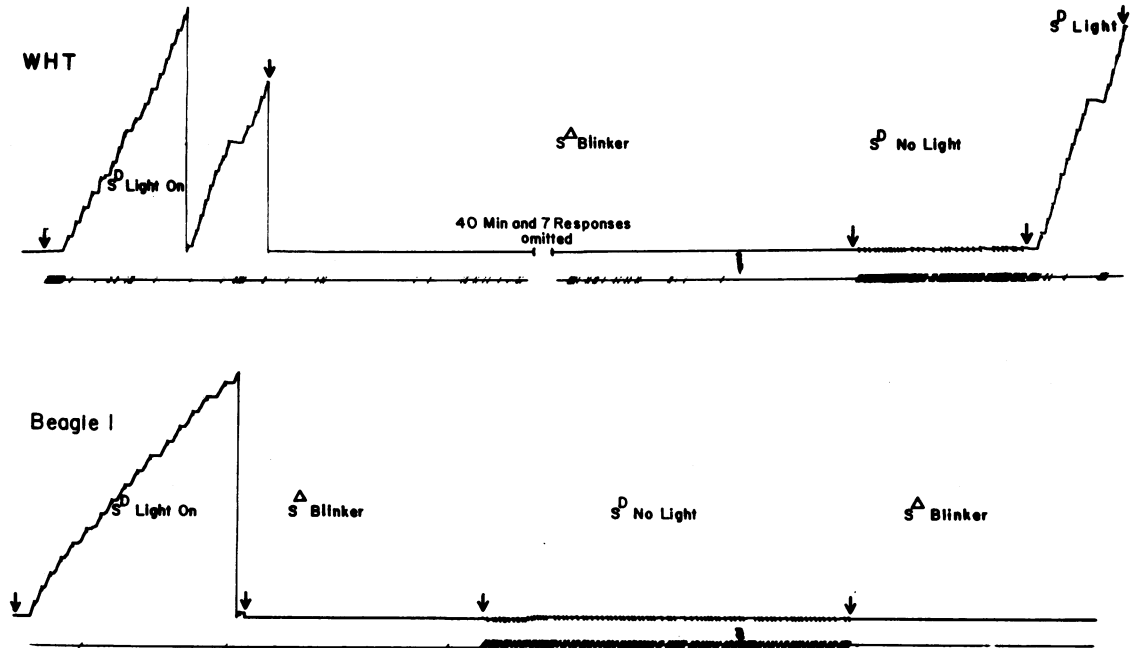
Fig. 3. Cumulative records of the final performance on mult FR 33_{vocal} S^Δ_{vocal} and bar FR 33_{bar}.

tions was impossible, and Beagle 2 was dropped from the experiment.

Figure 3 shows the final performance of WHT and Beagle 1 on mult FR 33_{vocal} S^Δ_{vocal} and bar FR 33_{bar}. Vocal responses are recorded as in the previous figures. Bar-nosing responses are recorded by the separate event marker (bottom line). A diagonal mark on the vocal-response line indicates each reinforcement, whether it was obtained by vocal or bar responding.

Figure 3 shows that WHT tends to make bar responses under all stimulus conditions. At the first arrow, for example, WHT makes quite a few bar responses in the S^D for vocal responding before making the first vocal response, and continues to make a few bar responses throughout the vocal component. Sporadic bar responding also occurs in the S^Δ component, but not vocal responding. Apparently, the subject's extensive history of bar responding before this experiment had not been completely extinguished. However, the record indicates that remarkably good stimulus control was obtained, particularly for the vocal response.

The record for Beagle 1 supports the notion that excellent multiple-stimulus control can be obtained on a two-response multiple sched-

ule. The lower incidence of bar responses during the S^Δ and the S^D for vocal responding tends to support our explanation for WHT's inappropriate bar responses. For both WHT and Beagle 1, the control by discriminative stimuli is consistently at least as adequate for the vocal response as for the bar response.

Following the session shown in Fig. 3, the schedule of reinforcement was changed from mult FR 33_{vocal} S^Δ_{vocal} and bar FR 33_{bar} to chain FR 10_{bar} FR 10_{vocal}. The discriminative stimuli which were appropriate in the multiple schedule were still appropriate in the chain schedule; i.e., 10 bar responses in the "No Light" condition switched the stimulus to the "Light On" condition, in which 10 vocal responses were required for reinforcement. Because the responses were not physically incompatible, S could be reinforced by any combination of vocal and bar responses meeting the chain criterion. For example, S could emit both vocal and bar responses simultaneously, in which case 20 vocal and 20 bar responses would be made before reinforcement. Other possible combinations would result in a disproportional number of either the vocal or bar responses.

Figure 4 (top record) shows the initial effect of the change from the multiple to the chain
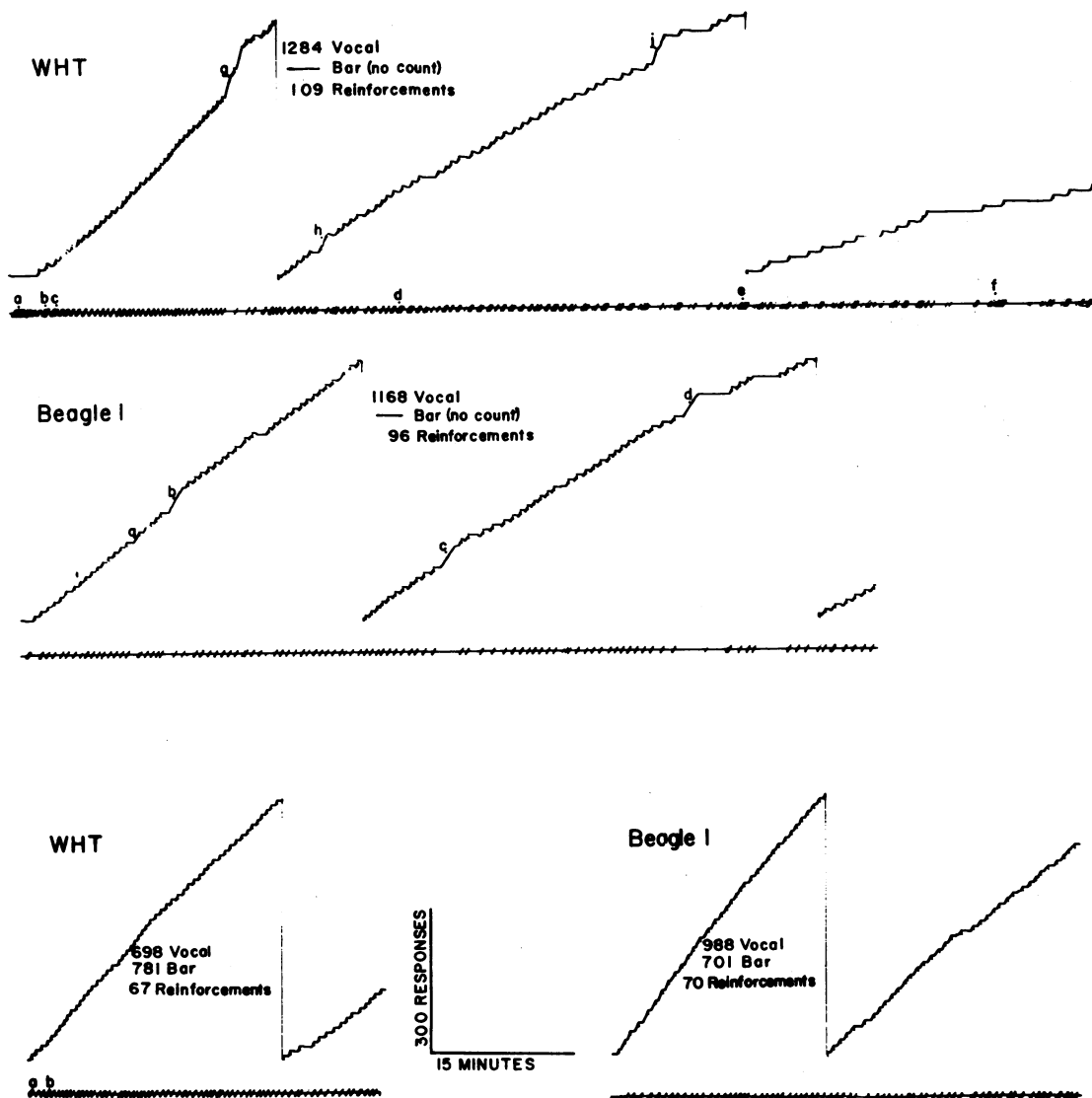
Fig. 4. Cumulative records for two Ss showing the change from a multiple to a chain schedule of reinforcement (top and middle sections) and final performance on the chain schedule (bottom section).

schedule for WHT and Beagle 1. Subject WHT showed an initial persistence of bar responding after the change into the vocal-response stimulus condition. The result was the output of approximately 100 bar responses (a) before the change to vocal responding. This large output of bar responses continued for several reinforcements (b,c), though at lower values, and to some extent was evident throughout (d,e,f) the session. Extended runs of vocal responses in the S^D for bar responding also occurred, as at g,h, and j. This degree of loss of stimulus control might be expected after a schedule change.

Figure 4 (middle record) shows Beagle 1's record of the transition from the multiple to the chain schedule. It differs in one detail from the record for WHT. There were few instances when Beagle 1 failed to switch from bar responding to vocal responding when the S^D changed. However, there were instances when S emitted vocal responses during the S^D for bar responses, as at a, b, c, and d. It is interesting to note that vocal responses began to appear in the bar S^D only after a number of reinforcements, indicating that the good discriminative control over the behaviors in the multiple schedule performance (Fig. 3) trans-

fered to the new schedule. The disruption seen later was probably a result of the differential reinforcement of bar versus vocal responding on the chain schedules, i.e., the fact that only vocal responses were immediately reinforced.

Figure 4 (bottom record) shows a later performance by both Ss on the chain schedule. This figure shows that for WHT the stimulus contingencies of the chain schedule now had much better control over the behavior. Only rarely were there large numbers of bar responses in the S^D for vocal responses (a, b); and in no instance was there a conspicuous example of vocal responding in the S^D for bar responses. The number of bar and vocal responses are given on the figure, and these may be compared with the minimum 670 responses necessary to obtain the 67 reinforcements received.

The bottom record of Fig. 4, showing the performance of Beagle 1, has some particularly interesting features. Early in the session, Beagle 1 tended to respond vocally and to nose the bar almost simultaneously. Consequently, the number of vocal responses was excessively high. The tendency dropped out as the session progressed. Of particular interest is the fact that the bar responding stopped when the S^D for vocalizing was presented. The minimum number of responses for 70 reinforcements is 700. The number of responses actually made was 988 vocal and 701 bar responses (the first reinforcement followed about 3 responses). Considering the data of WHT, the interpretation that bar responding is more readily controlled by discriminative stimuli than are vocal responses is unreasonable. More likely, the result is a function of these uniquely compatible responses interacting with a chain schedule which could well produce just this sort of "superstitious" response topography (the almost simultaneous barking and bar pressing).

DISCUSSION

The data of this study, as well as the cited studies suggest that the vocal responses of subhuman organisms may be treated as operant behavior. Vocal responses of some avian and mammalian species have been shown to have functional relations to various behavioral variables which are similar in detail to the relations obtained with topographically different responses. Although the gamut of behavioral variables has not yet been investigated using subhuman vocal responding, ample evidence exists to deny the hypothesis that the vocal behavior of organisms is *necessarily* "emotional" in character, and that it is necessarily elicited, not emitted. This does not mean that vocal responses cannot be elicited, or that having been elicited, they cannot be controlled by the use of classical conditioning procedures. In fact, there is some indication that the initial vocal responding of the dogs in this experiment was elicited (particularly for WHT).

One major exception in the studies of operant conditioning of vocal responses is the study by Mower et al. (1948). Using an avoidance-conditioning paradigm with the rat, these investigators successfully increased the frequency of occurrence of a simple running response; but they were unable to do so with a vocal response.

Successful respondent conditioning of vocalization in the rat was achieved by Cowles, J.T., and Pennington, L.A. (1943), among others. Mowrer et al. explained the failure of operant conditioning in terms of natural selection. Their suggestion was, essentially, that vocalization in the presence of a conditioned aversive stimulus has little survival value. The hidden animal which vocalizes in the presence of a predator is obviously not making a response having survival value, but, on the contrary, is exposing itself to danger. Furthermore, these authors claim that arboreal and flying animals have greater freedom in vocalizing because they can more readily escape the dangers which beset terrestrial animals. Finally, in domesticated animals (like the dogs in this study), vocalization is not selected against because no predators would act upon this behavior to make it dangerous. If this reasoning is correct, it would be expected to apply only to avoidance behavior. In other words, on the basis of the successful experiments in the operant conditioning of vocalization, operant conditioning with positive reinforcement as well as escape conditioning of the vocal response would be expected to be successful in the rat. Nevertheless, these experiments still remain to be done.

The fact that at least some animal vocalizations appear tractable to both respondent

and operant-conditioning procedures again raises the question of the differences (if any) between the types of responses that are modified by these two clearly different conditioning paradigms (Skinner, 1935, 1937, 1938). If it is assumed that the subjects' initial vocalizations in this study were elicited (by the "bark" of the experimenter for WHT and by confinement in the experimental enclosure for the beagles), this experiment is similar to the one presented by Konorski and Miller (1937). Also, Skinner's (1937) reply agrees, at least in part, with our argument, namely, that the vocalization data are examples of operant conditioning. In view of the preponderance of data indicating that lower-organism vocalizations have the properties of operants, independently of whether the responses are initially elicited or emitted, Skinner's (1937) distinction between operants and respondents appears somewhat arbitrary.[3]

The statement requiring revision is: "the operant-respondent distinction is the more general since it extends to unconditioned behavior as well" (Skinner, 1937, p. 274). This statement explicitly contends that the two types of behavior are specifiable without reference to any conditioning procedure. It also implies that elicited behavior can be conditioned only by respondent conditioning procedures, and that emitted behavior can be conditioned only by operant-conditioning procedures. Skinner applies this reasoning directly to animal vocalization in his discussion when he says: "It is unlikely, moreover, that verbal behavior in the present sense arose from instinctive cries. Well-defined emotional and other innate responses comprise reflex systems which are difficult, if not impossible, to modify by operant reinforcement" (Skinner, 1957, p. 463).

On the other hand, the data of this experiment support the notion that the range of applicablity of operant-conditioning procedures is larger than that originally suspected by Skinner.

The terms operant and respondent probably should be restricted to conditioned

rather than unconditioned behavior, since the *a priori* classification of behavior into types lacks experimental validity and contributes little to behavioral analysis. Likewise, the vocal behavior of animals probably should not be classified as exclusively respondent. The fact that vocal behavior of animals can be modified by means of operant reinforcement makes it appear as likely that it constitutes an evolutionary precursor of verbal behavior in the human being.

REFERENCES

Cowles, J. T., and Pennington, L. A. An improved conditioning technique for determining auditory acuity of the rat. *J. Psychol.*, 1943, **15**, 41-47.

Ferster, C. B., and Skinner, B. F. *Schedules of reinforcement.* New York: Appleton-Century-Crofts, 1957.

Ginsburg, N. Conditioned vocalization in the Budgerigar. *J comp. physiol. Psychol.*, 1960, **53**, 181-186.

Konorski, J. *Conditioned reflexes and neuron organization.* Cambridge: University Press, 1948.

Konorski, J., and Miller, S. On two types of conditioned reflex. *J. gen. Psychol.*, 1937, **16**, 264-272.

Krasner, L. Studies of the conditioning of verbal behavior. *Psychol. Bull.*, 1958, **55**, 148-170.

Lane, H. Control of vocal responding in chickens. *Science*, 1960, **132**, 37-38.

Lane, H. Operant control of vocalizing in the chicken. *J. exp. Anal. Behav.*, 1961, **4**, 171-177.

Lawicka, W. The effect of the prefrontal lobectomy on the vocal conditioned reflexes in dogs. *Acta. Biologiae Experimentalis*, 1957, **17**, 317-325.

Mowrer, O. H., Palmer, Florence, and Sanger, Marjorie D. Individual learning and "racial experience" in the rat, with special reference to vocalization. *J. genet. Psychol.*, 1948, **73**, 29-43.

Salzinger, K. Experimental manipulation of verbal behavior: a review. *J. gen. Psychol.*, 1959, **61**, 65-94.

Skinner, B. F. Two types of conditioned reflex and a pseudo type. *J. gen. Psychol.*, 1935, **12**, 66-77.

Skinner, B. F. Two types of conditioned reflex: a reply to Konorski and Miller. *J. gen. Psychol.*, 1937, **16**, 272-279.

Skinner, B. F. *Behavior of organisms.* New York: D. Appleton Century Co., 1938.

Skinner, B. F. *Science and human behavior.* New York: The MacMillan Co., 1953.

Skinner, B. F. *Verbal behavior.* New York: Appleton-Century-Crofts, Inc., 1957.

Thompson, W. R. Social behavior. In Roe, Anne, and Simpson, G. (Eds.), *Behavior and evolution.* New Haven: Yale University Press, 1958. Pp. 291-310.

Waller, M. B. A manipulandum for use with dogs. *J. exp. Anal. Behav.*, 1960, **3**, 311-312.

---

[3] Skinner's alternative explanation (1953) that an operant response may arise which imitates a respondent or partially overlaps with it seems unreasonable in view of the lack of data on the exact topographical differences between the operants and respondents in question and also between one operant and another.