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Qualitative versus Directional Cues in Two Forms of Differentiation

Abstract. *Dogs given opportunities to base their instrumental conditioned responses in differentiation learning on either the quality of the auditory conditioned stimulus (for example, metronome versus buzzer) or the direction of its source (in front or behind) choose different cues in different tasks. In* $S_1 \rightarrow R_1$, $S_2 \rightarrow R_2$ *(left leg–right leg) differentiation they exclusively use directional cues and are almost unable to learn this task when only quality cues are available. When confronted with Pavlovian* $S+ \rightarrow R$, $S- \rightarrow$ *no R (go–no go) differentiation, however, they generally learn on the basis of quality cues, although some animals also attend to the directional cues. Thus an animal's success or failure in a given differentiation procedure depends not only on its ability to discriminate the stimuli but also on the task with which it is confronted.*

Lawicka (*1*) has shown that, in a free-moving situation, success or failure of training in go left–go right differentiation or go–no go differentiation depends on the character of auditory cues used for the particular task. While for go left–go right differentiation the adequate cues are provided by auditory stimuli presented from *different directions*, for go–no go differentiation they are provided by stimuli of *different quality*. We have now further investigated the same problem, using a different technique.

We used 29 dogs in a Pavlovian soundproof conditioned-reflex (CR) chamber. An animal, placed on a stand, was given food by remote control from a feeder situated before him. An instrumental CR consisted in placing the left or right foreleg on the feeder in response to a conditioned stimulus (CS); intertrial intervals were about 1 minute.

In experiment 1, 11 dogs were trained to place their right forelegs on the feeder in response to the sound of a metronome situated in front of

them (Ma) and to place there their left forelegs in response to a buzzer situated behind them (Bp). During training the two stimuli were presented randomly; 5 seconds after presentation of the stimulus the appropriate leg was passively placed on the feeder and food was immediately delivered. Passive placement was remotely controlled by a system of ropes and pulleys. After a few sessions the animals started to execute the trained movements actively in response to the CS's. If the response was correct, food was immediately presented; if incorrect, the CS was discontinued and food was not delivered. If a dog did not respond to 5 seconds of CS, it was prompted by a tug on the proper leg. Eight reinforced trials were given per session, each CS being presented four times in random order.

The task was mastered to a criterion of 80 consecutive correct responses in an average of 230 (range, 120 to 360) trials; these scores include the trials with passive movements. During each of the ten test sessions that followed, interspersed among the regular trials were two trials with (i) a buzzer presented in front of the animal (Ba) and (ii) a metronome presented behind it (Mp). In all trials either movement was reinforced by food. The results (Table 1) show that in eight dogs at least 90 percent of the responses were determined by the direction of the CS, with total neglect of its quality; that is, the metronome presented from behind evoked the same movement as the buzzer from behind, while the buzzer presented in front evoked the same movement as the metronome in front. In three other dogs the responses were mixed. In no dog, however, did the quality cue prevail over the directional cue.

Further evidence indicating the significance of the directional cues for right leg–left leg differentiation is provided by the results of a control procedure. Six dogs were similarly trained except that both CS's sounded from the same point in front of the animal, so that the directional cue was absent; three of them eventually mastered the task after 1000 to 1500 trials, while the other three could not learn even after longer training. In all six dogs symptoms of neurosis developed from time to time. In contrast, when two CS's of different modalities (visual versus auditory) were presented in front of two dogs, the task of right leg–left leg differentiation was quickly learned within about 250 trials.

In experiment 2, ten dogs were trained in go–no go differentiation, the instrumental response being movement of the right foreleg. Response by this movement to the positive CS was always reinforced by food, while the negative CS never brought food. Either the buzzer or a 900-cy/sec tone was the positive CS, while the metronome or a 600-cy/sec tone was the negative CS. For five dogs the positive CS was in front of the animal and the negative one was behind; for the other five these positions were reversed. The dogs learned the buzzer-metronome differentiation almost immediately; the high tone–low tone differentiation required a few hundred trials.

When the animals were responding correctly in 100 percent of the trials, 20 test trials were given in the same way as in experiment 1—but always without reinforcement, so as not to teach the animal to respond with the movement to the new stimulus combination. The results (Table 2) show that for every dog but one the negative CS placed in the position of the positive CS completely preserved its negative significance—that is, the animals never performed the taught movement in response to it. As for the positive CS placed in the position of the negative CS, it maintained its positive significance in the majority of trials with seven dogs, while negative responses prevailed in three dogs. In all, the animals reacted according to the quality of the CS in 80 percent

Table 1. Results of test trials in $S_1 \rightarrow R_1$, $S_2 \rightarrow R_2$ differentiation with 11 dogs, in which the metronome was shifted behind (Mp) and the buzzer in front of (Ba) the animals.

Responses (No.)					
Mp			Ba		
To quality (M)	To direction (p)	None	To quality (B)	To direction (a)	None
0	9	1	0	10	0
0	10	0	0	10	0
1	8	1	0	10	0
0	10	0	0	10	0
0	10	0	1	9	0
0	10	0	0	10	0
0	10	0	2	8	0
5	5	0	1	9	0
2	8	0	2	8	0
0	10	0	0	10	0
4	1	5	0	10	0
		Totals (%)			
10.9	82.7	6.4	5.5	94.5	0

Table 2. Results of test trials in $S_1 \rightarrow R$, $S_2 \rightarrow$ no R differentiation with ten dogs. Symbols B, buzzer; M, metronome; T_1, 900-cy/sec tone; T_2, 600-cy/sec tone; a, presented in front; p, presented behind.

CS+	Reverse location	Responses (No.) to		CS−	Reverse location	Responses (No.) to	
		Quality	Direction			Quality	Direction
Ba	Bp	0	10	Mp	Ma	10	0
Ba	Bp	3	7	Mp	Ma	9	1
Ba	Bp	9	1	Mp	Ma	10	0
Bp	Ba	4	6	Ma	Mp	10	0
Bp	Ba	10	0	Ma	Mp	10	0
Bp	Ba	7	3	Ma	Mp	10	0
T_1a	T_1p	9	1	T_2p	T_2a	10	0
T_1a	T_1p	8	2	T_2p	T_2a	0	10
T_1p	T_1a	10	0	T_2a	T_2p	10	0
T_1p	T_1a	10	0	T_2a	T_2p	10	0
		Totals (%)					
		70	30			89	11

of the trials and to the direction of the CS in only 20 percent.

So, as Lawicka discovered, animals trained in a differentiation procedure requiring two different instrumental responses to two auditory stimuli mainly use directional cues; they are almost unable to learn the task when confronted with purely qualitative cues. On the other hand, in a go–no go differentiation procedure based on reinforcement-versus-nonreinforcement of responses to two auditory stimuli mainly utilize qualitative cues.

These facts have been tentatively interpreted in detail (*2*). It is notable that monkeys (*3*) also can establish without difficulty a go–no go differentiation between two different tones emanating from the same point, while their go left–go right differentiations between these stimuli are as difficult as they are for dogs; in contrast, the go right–go left differentiation between directional cues is easy.

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References and Notes

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4. We thank Mortimer Mishkin for assistance with the manuscript.

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