AUTOMATIC STIMULUS ATTENUATOR FOR RAPID DISCRIMINATION TRAINING¹

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An animal must often be taught to perform a complex discrimination accurately with a minimum amount of training. Achieving a reliable discrimination may take considerably longer if the complex problem is given immediately after initial shaping than if the final problem is approached through a number of easier stages (Pavlov, 1927, pp. 121-122). Terrace (1963) found that a pigeon trained by slowly increasing the difficulty of the task after each correct response showed far fewer errors in subsequent performance than one trained for the same amount of time on the final problem. Moore and Goldiamond (1964) successfully used a similar procedure with children, and Scheckel (1965) has applied similar techniques in training monkeys on delayed match-to-sample problems.

The present note describes a simple, reliable, and inexpensive device for modifying a stimulus as a consequence of the animal's response in such a way as to increase the difficulty of a problem given a correct response, and to decrease it given an incorrect response. The device consists of a bi-directional motor, geared down to $\frac{1}{3}$ rpm, rotating a set of ganged rheostats. The motor can be driven in either direction by an appropriate relay control circuit connected to the motor windings. The rheostats can be placed in series with a light source for changing the intensity of a negative cue, in an RC circuit for changing the length of a time delay, or in any other circuit devised to change systematically an experimental variable contingent on the animal's performance. The amount of change in each step is a function of the amount of time the relay control circuit is activated.

Such a device has been constructed and tested successfully on two animal species. Four rats were automatically transferred from a simple light-dark discrimination to a much more difficult vertical-horizontal pattern discrimination in three 1-hr training sessions. The attenuator has also been used to train a monkey in a match-to-sample problem where the odd pattern was initially dimmed to facilitate learning. The monkey eliminated the brightness cue by correct responding in the second session.

A third rheostat ganged to the two stimulus control rheostats has been used in a voltage dividing circuit to provide a voltage proportional to the setting of the attenuating rheostats. This voltage was used as an input to a servo-recorder, generating a cumulative record which steps upward when the animal is re-

Fig. 1. Circuit diagram of the attenuator. As simultaneous closure of both motor winding relays may weld the relay contacts, the control circuit should be designed to prevent this.

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sponding correctly and the problem is becoming more difficult, and downward when it is responding incorrectly.

This record has useful applications beyond initial training. For example, after ablation of the visual cortex of rats trained with this device, post-operative records became a crude index of the brightness difference limens of animals which could not successfully relearn a pure pattern discrimination.

By using "one-shot" timing circuits to drive the motor, the size of the upward and downward steps can be independently varied and used as another variable for studying the learning process. We have used downward steps larger than upward so that chance responding would rapidly increase the brightness difference back to a level the animal would readily follow.

Total cost of the unit is about \$25, the motor, a Hurst $\frac{1}{3}$ rpm bi-directional synchronous motor, accounting for about half. The

rheostats used should be selected with respect to the intended application. The entire attenuator can be assembled in 8 hr in a modestly equipped machine shop.

Low cost and simplicity are major advantages of the unit, but these factors preclude any high degree of precision. Use of the device is thus limited to training procedures where terminal performance is the primary concern.

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