Compounding of stimuli maintaining opposing response tendencies in an instrumental avoidance situation

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A light and a buzzer each maintained an opposing directional response that avoided shock in a shuttlebox. When the light was combined with the buzzer on the side on which Ss avoided to the buzzer, latency of avoidance was greater than was latency to the buzzer alone. When the buzzer was combined with the light on the side on which Ss avoided to the light, latency was less than it was to the light alone. The results were interpreted in terms of response summation and differential stimulus control.

When two stimuli, each capable of maintaining a response, are combined, their compound maintains a greater response tendency than either stimulus alone (Hull, 1940; Wolf, 1963; Miller, 1969a, b). With an instrumental-avoidance response, this summation of the response tendencies to the single stimuli results in a significantly shorter latency to the compound than to either single stimulus (Miller, 1969b). In this study, Ss were run in a two-way avoidance situation, with either light or tone warning stimuli presented on each trial. In the present study, the single stimuli came, through conditioning, to maintain an opposing response tendency. This was accomplished by having each stimulus maintain an avoidance response of either moving from left to right or from right to left. Summation would predict that when these stimuli were compounded, the resultant summation of the opposing response tendencies should produce an increased latency of response.

METHOD

The Ss were 10 male albino rats, 180 days old and maintained on free food and water. The apparatus was a 22 x 4 x 6 in. flat-black standard plywood shuttlebox, with a grid floor of steel rods spaced ½ in. apart. The stimuli, a 25-W light bulb and a Potter and Brumfield BU 120-V buzzer, were positioned at the midline of the box, the light 9 in. from the floor on the inside rear wall, and the buzzer on a platform outside the box, 6 in. away from the rear wall. A clear Plexiglas roof was installed 3 in. below the height of the light in order to prevent S from making any contact with the light. The shock source was a Grason-Stadler shock generator. Latencies were measured with a Stoelting electric timer, accurate to .01 sec.

The Ss were run in a two-way avoidance situation. The initial training consisted of having Ss learn to move from one part of the box to the other in order to avoid shock. Ss were placed in the right- or left-hand half of the box on alternate days. For seven of the Ss, the light was presented only when Ss were on the left half and the buzzer only when they were on the right half. The other three Ss had buzzer on the left and light on the right. If S crossed the midline to the other side within 10 sec after stimulus onset, it avoided shock, and the light or buzzer was terminated. If S did not cross within 10 sec, shock was presented until S moved to the other side, whereupon both shock and stimulus were simultaneously terminated. The same procedure was repeated on the other side. Latency, the time from stimulus onset until S crossed the midline, was measured. If S did not cross within 10 sec, latency was recorded as 10 sec. Shock was applied to the side S had just crossed during the 30-sec intertrial interval (ITI) to prevent premature crossings. Ss were given 20 trials to each stimulus each day. Shock intensity was adjusted for each S to produce a mean latency around 3-6 sec. Intensities used varied from .13-.50 mA.

The Ss were run under this procedure for about 7-10 days, by which time they had reached a criterion of at least 90% avoidance. The second phase of training was then initiated. On 10 of the 20 trials in one side of the box, the stimulus to which S was to make the avoidance response was presented. For the other 10 trials, the stimulus to which S made an avoidance response in the opposite direction was presented. Thus, those Ss that moved from left to right to the light (buzzer) had the buzzer (light) presented on that side for 10 trials. The same procedure was repeated on the other side. Which stimulus occurred on each side on each trial was determined randomly, with 10 presentations of each stimulus on each side. The opposite-direction stimulus was presented for 10 sec. If S moved to the other side during presentation of this stimulus, it was shocked. In order to avoid being shocked, S had to remain on the same half of the box for 10 sec. This procedure was introduced in order to further strengthen the learning of opposing response tendencies to light and buzzer. Ss were generally making 90%, or better, correct responses to each of the four stimulus conditions by the end of the second session but were run for about seven sessions before compounding began.

Compounding consisted of presenting both light and buzzer simultaneously. Ss

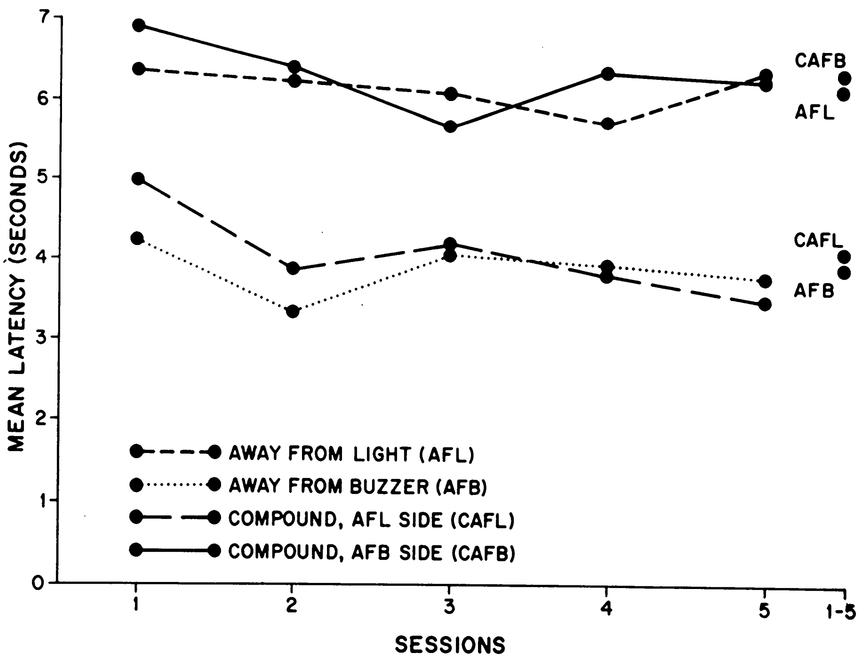

Fig. 1. Mean latencies of avoidance to single stimuli and their compound.

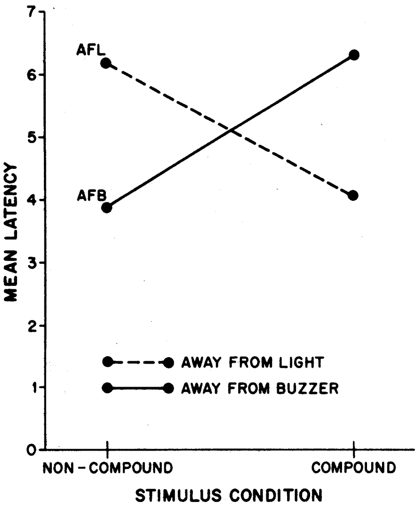

Fig. 2. Interaction between Stimulus Condition and Direction of Movement.

were never shocked during a compound presentation, regardless of whether or not they made an avoidance response. Eight compound trials were presented during each session, four tests on the left-hand side and four tests on the right. Compound tests were always programmed to occur on trials where S was required to make an avoidance response to the single stimulus, since an avoidance response to the compound on a trial where S would normally withhold the response would throw off the ensuing sequence of single-stimulus presentations. If S made an avoidance response, the latency was recorded, and the sequence of normal single-stimulus presentations was continued until the next compound presentation. If S did not avoid, the compound was terminated after 10 sec. The single stimulus that would have normally occurred for this trial was then presented after the 30-sec ITI, and the normal sequence of single-stimulus presentations was continued. The particular trials on which the compound was presented was determined randomly. Two such orders were used. Ss were tested over five sessions, for a total of 50 compound tests.

RESULTS AND DISCUSSION

The pooled results for the 10 Ss for each session of compound testing are presented in Fig. 1. At the right of the figure are latencies averaged for the five sessions. The single-stimulus presentations when S was to withhold the response are not shown. A Treatment by Treatment by Subjects analysis of variance of the latencies showed no significant difference ($p > .25$) of either main effect of stimulus condition (compound vs noncompound) or direction of movement (away from light vs away from buzzer). However, the interaction between these two variables was significant at $p < .01$. The interaction is illustrated in Fig. 2. Duncan's (1955) multiple-range test was used to make comparisons between the means of the interaction. The following differences were significant at $p < .01$: noncompound, moving away from the light (AFL), vs noncompound, moving away from the buzzer (AFB); noncompound AFL vs compound AFL; compound AFB vs compound AFL; and noncompound AFB vs compound AFB. The other two comparisons were nonsignificant ($p > .25$).

The hypothesis that summation of opposing response tendencies would produce an increase in latency was supported when the light was compounded with the buzzer on the AFB side. The latency to the compound was significantly longer than the latency to the buzzer alone. However, when the buzzer was compounded with the light on the AFL side, the latency to the compound was significantly shorter than the latency to the light alone. This result is opposite to what was predicted but is identical to results found by Miller (1969b) when each stimulus did not maintain an opposing tendency. The possibility that Ss did not learn the opposite directional response from that of the light when the buzzer was presented on the AFL side seems unlikely for at least two reasons. First, Ss withheld running to the buzzer on the AFL side, just as they withheld running to the light on the AFB side. Second, observation of Ss' behavior during compounding doesn't support such an explanation. Several Ss initially backed up and crouched in a corner when the light and buzzer were compounded. This behavior occurred during compounding on both sides. The effect of this backing up and crouching was to increase latency on the AFB side; however, on the AFL side, this response was rapidly reversed, to the extent that latency was significantly reduced.

A more reasonable explanation may rest in the amount of stimulus control exerted by each stimulus. The light may have exerted more control over responding than the buzzer. When the light was combined with the buzzer on the AFB side, the response of withholding running to the light dominated and Ss' latencies increased. When the buzzer was combined with the light on the AFL side, the light was again dominant, even to the extent that the directionality of the buzzer was rapidly reversed, so that the latencies significantly decreased. In the typical stimulus-compounding situation, where the individual stimuli each maintain complementary response tendencies, differential stimulus control would not likely be as evident, since both stimuli are affecting responding in the same direction. However, the present results support the possibility that when stimuli maintaining opposing response tendencies are combined, one stimulus may be dominant, so that it overrides and controls the nature of responding to the other stimulus. Differential stimulus control has been demonstrated where the conditioned stimulus used in training is a complex stimulus consisting of light and tone or different stimulus patterns. Response strength of the individual elements of the complex is predominantly controlled by only one of the stimuli (Reynolds, 1961; Thompson & van Hoesen, 1967; Birkimer, 1969). The present results suggest that this differential stimulus control may also exist when the complex stimulus is formed by compounding individual conditioned stimuli.

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