The second-order conditioning of fear in rats¹

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The phenomenon of second-order conditioning (SOC) in rats was investigated, using the conditioned suppression technique. A between groups noncontingent stimulus presentation control procedure was employed. Significant SOC was obtained providing additional evidence for the reality of the SOC phenomenon.

The phenomenon of second-order conditioning (SOC) has recently come under renewed experimental attack (Davenport, 1966; McAllister & McAllister, 1964; Murphy & Miller, 1957). The most convincing successful demonstration of SOC has been that of Davenport (1966) employing the conditioned suppression technique. In this experiment Davenport ran both within-and-between-subject controls. In addition, one-trial-per-day scheduling was employed and SOC trials were not intermixed with UCS presentations.

The present research was designed to supplement that of Davenport. The between-subject control technique of noncontingent stimulus presentations, recently suggested by Rescorla (1967) for classical conditioning, was used rather than the backward conditioning controls of Davenport. Unlike the Davenport report, the present experiment utilized a single training procedure throughout, making direct experimental-control comparisons possible.

Method

The Ss were 24 experimentally naive male albino rats of the Holtzman strain, 140-145 days old at the start of the experiment. The Ss were maintained at 80% of their free-feeding weight throughout the experiment. Six Ss were discarded during running, four due to illness and two for failure to generate stable baseline response rates.

The apparatus consisted of four Gerbrands Model C rat test chambers, controlled by standard programming equipment. CS₁ was a 74 dB, 450 cps tone of 10 sec duration which interrupted the ambient white noise level of 77 dB. CS₂ was the increase in illumination provided by increasing the houselight and cue light voltage from 10 VAC to 20 VAC, and was of 30 sec duration. The UCS was an 0.5 sec grid shock delivered to all four chambers, which were wired in parallel, by a Grason-Stadler shock generator set at a nominal voltage of 4 mA.

Throughout the experiment each daily session was 23.1 min long. With one exception no more than one trial per session was ever given. Trial onset was in the middle 13.1 min of a session, and was randomly determined each day. The experiment was run in five stages, all Ss treated identically through the first four. In Stage 1 Ss received standard bar press training

followed by 24 sessions of VI-60 sec LH-20 sec experience (a lapse of 34 days was necessary between Sessions 7 and 8 of this stage; otherwise Ss were run daily). In Stage 2, Pre-exposure 1, CS₁ was exposed without programmed consequence for four trials. In Stage 3, first-order conditioning (FOC), CS₁ was paired with the UCS in a delay conditioning paradigm for seven trials. Two sessions in which no trial was given were interspersed among the seven FOC sessions. In Stage 4, Pre-exposure 2, CS₂ was presented without programmed consequence for six trials. The first two trials of this stage were presented in the same session.

At the end of Pre-exposure 2, the 18 remaining Ss were randomly divided into two groups of nine Ss each. During the 10 trials of the SOC phase members of the experimental group were presented with CS₂ followed by CS₁ (no UCS was presented) in a delay conditioning paradigm. The control group received noncontingent presentations of CS₁ and CS₂ for 10 trials. The schedule of these noncontingent presentations was determined as follows: the interval between CS₁ onset and CS₂ onset was allowed to vary between plus and minus 250 sec. The resulting 500 sec range was divided into ten 50 sec segments. Using a table of random numbers one particular time from each interval was selected and assigned to a trial. It was felt that although this procedure was a technical violation of Rescorla's (1967) suggestion of random presentation, it was necessary in order to insure a balanced schedule of stimulus presentations within the relatively few trials available for study during SOC.

The dependent variable used throughout the experiment was response suppression. This was measured by a ratio of the form $R_{CS}/(R_{CS} + R_p)$, in which R_{CS} is the rate of responding during the CS and R_p the rate during the 100 sec interval immediately preceding the trial.

Results and Discussion

The results of the experiment are presented in Fig. 1. It is clear that there were no significant differences between the experimental and control groups in Pre-exposure 1, FOC, or Pre-exposure 2. A groups by days analysis of variance was performed on the results of each stage. There were no significant effects during Pre-exposure 1. The only significant effect during FOC was a decrease in the suppression ratio across trials ($F = 34.45$, $df = 6/96$, $p < .001$) representing the fear conditioning process. During Pre-exposure 2 there was a significant increase in the suppression ratio across trials ($F = 3.97$, $df = 4/64$, $p < .001$) due to the adaptation of the novelty effects of CS₂.

Two analyses were performed on the data obtained

Fig. 1. Mean CS₁ and CS₂ suppression ratios of the experimental and control groups during the experiment.

during the SOC phase. In the analysis of CS₁ suppression during SOC there was one significant effect, an increase in mean CS₁ suppression ratio across SOC trials ($F=2.99$, $df=9/144$, $p<.01$). In performance during CS₂, the experimental group displayed significantly more suppression than did the controls ($F=11.24$, $df=1/6$, $p<.01$). This was the only significant term involving groups in any of the analyses performed.

These findings represent a clear demonstration of second-order conditioning. This conclusion is further supported by the fact that both groups performed similarly during CS₁ in the SOC phase since this would seem to further eliminate any pseudoconditioning arguments. It is also interesting to note that the CS₂ performance of the controls during SOC was neutral throughout with neither increased nor decreased response rate during this stimulus. This is what one

would expect since, as Rescorla (1967) points out, with the noncontingent control procedure CS₂ has no signal or information value.

References

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Note

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