Methamphetamine's effect on SDR: Replication and extension*

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Methamphetamine's effect on serial discrimination reversal learning (SDR) was studied in rats; selected doses reduced errors during acquisition of SDR with successive reversals spaced by either 24 or 48 h.

Amphetamine drugs (e.g., d-amphetamine and methamphetamine) facilitate behavior in simple behavioral situations (Cole, 1967; Kelleher & Morse, 1968), but effects of amphetamine drugs on complex behavior are little studied, and the results of these few studies do not provide a clear picture of effects (Grossman & Sclafani, 1971). Therefore, to study the effects of amphetamines in complex learning situations, Kulig & Calhoun (1972) used a serial discrimination reversal (SDR) procedure, and they demonstrated that methamphetamine enhanced learning of SDR. The present study replicated this finding and extended it to SDR learning with reversals spaced 48 h.

EXPERIMENT I

Kulig & Calhoun (1972) reported that one administration of methamphetamine (0.5 or 2.0 mg/kg IP), 10 min before the first session of Reversal 2 in a series of 10 discrimination reversals, reduced trials and errors to criterion on that and subsequent reversals. Experiment I of this paper replicated the Kulig and Calhoun experiment, although the 2.0-mg/kg dose was not studied, since it had markedly reduced responding on rewarded trials.

Method

Subjects

Eighteen Sprague-Dawley derived rats, obtained from a commercial supplier at 200-250 g, served as Ss. During the experiment they were maintained on a 23-h water deprivation schedule, with access to water for 30 min after each daily session.

Apparatus

The apparatus consisted of aluminum operant chambers with a Gerbrands lever mounted in the front panel 8.25 cm above the grid floor. A drinking spout projected 2.75 cm into the chamber from the center of the front panel 4.5 cm above the grid floor, and was connected to a liquid delivery mechanism. A 6-W white cue light 6 cm directly above the lever presented light stimuli, and a speaker mounted in the center of the ceiling presented 1,000-Hz tone stimuli. During the sessions, the operant chambers were enclosed in large sound-deadened cubicles illuminated by a 7½-W red houselight. White noise in the experimental room masked laboratory noise.

Procedure

This experiment used a discrete-trial procedure with a successive discrimination (therefore, a go/no-go procedure). A Gellerman series of 20 elements ordered tone and light trials; the trials were 5 sec long and were spaced by a 6-sec intertrial interval (ITI). Each intertrial response caused the interval timer to reset, postponing the start of the next trial; this procedure reduced ITI responses to a minimum.

First, the rats were shaped to leverpress for a 0.1-ml drop of 9% sucrose solution; when leverpressing rate was high and stable, the discrete-trial procedure was introduced. During discrete-trial training, one of the stimuli appeared singly, a leverpress during the trial terminated it and delivered a reinforcement. The rats were responding on 95% of the trials after five sessions of discrete trial training. Following this preliminary training, the rats started discrimination training, during which a single response on an S+ trial terminated the trial and delivered reinforcement; but a response during an S− trial did not terminate the trial, and the first one counted as an error. Daily sessions of 360 trials continued until each rat reached a criterion of responding to 10 successive S+ trials with no intervening errors. When each rat reached the discrimination criterion, the session terminated and the rat was returned to its home cage; the next day the reversed discrimination started, and training continued until the rat reached criterion. After reaching criterion on the reversed discrimination, the rats were assigned randomly to treatment groups (drug or control); one group of rats reveived a single IP injection of 0.5 mg/kg of methamphetamine (N-methylamphetamine HCl dissolved in distilled water) 10 min before the first session of Reversal 2. Control group rats received an equal volume (1 mg/kg) of 0.9% saline.

Results

Preliminary analyses of the data showed that SDR performance in this situation was fully described by the number of initial responses on S− trials (errors) per reversal and the percent of responses on S+ trials (percentage of S+); therefore, these two measures were used as dependent variables. The drug group rats made fewer errors to criterion on most postinjection reversals (Fig. 1). A multivariant analysis of variance (errors to criterion on Reversals 0-8 dependent variables) demonstrated a significant group difference ($F = 8.64$, df $= 9/8$, $p < .05$), and the analysis shows that the drug group learned SDR more quickly than the control group. Percent S+ (lower part of Fig. 1) was affected on R_2 only, and this difference was not statistically significant.

Discussion

A rather trivial interpretation of the superior SDR performance for the methamphetamine animals on R_2 and R_3 would be that the drug temporarily heightened discrimination performance. This experiment minimized the time that the rat was influenced by the drug, since the animals were injected *only* before R_2, and improved performance on R_3 must reflect a genuine enhancement of SDR acquisition. However, Bauer & Duncan (1971) reported that one dose of d-amphetamine (2, 5, or 10 mg/kg) improved learning 24 h after injection, showing that a 24-h spacing of reversals does not allow for complete dissipation of all drug-caused changes. Thus, in the next
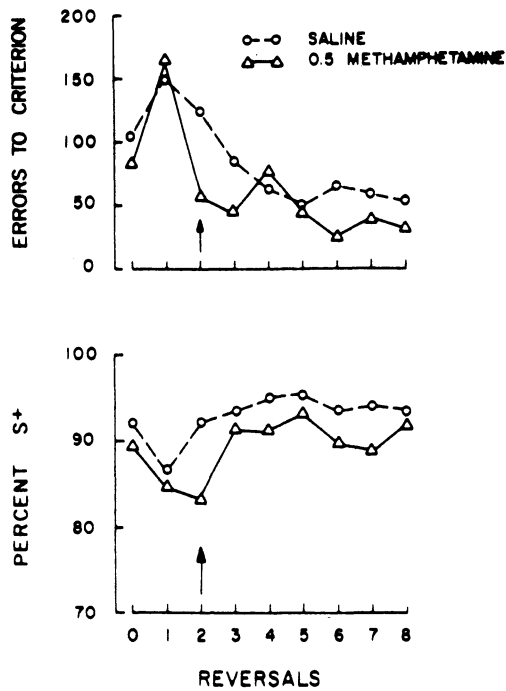
Fig. 1. SDR acquisition with reversals spaced by 24 h for rats injected with saline or 0.5 mg/kg of methamphetamine of Reversal 2 (injection indicated by arrow). Upper figure shows average errors to criterion, and the lower figure average percentage of S+ trials on which the rats responded. Nine rats per group.

experiment reversals were spaced by 48 h. so the time for a drug effect to dissipate was increased.

EXPERIMENT II

In this experiment, reversals were spaced by 48 h to allow more time for elimination of the drug from the organism before the next reversal. Acquisition of SDR with 48-h spaced reversals progressed more slowly than with 24 h. so the drug was administered on Reversal 3 to be nearest the point of maximum errors to more readily detect a drug effect.

Method

Subjects and Apparatus

Sixteen male Sprague-Dawley derived rats. obtained from a commercial supplier at 200-250 g. served as Ss. Maintenance conditions of the rats and the apparatus were described in Experiment I.

Procedures

The procedure was described in Experiment I: sessions were 300 trials. Animals were tested daily with one discrimination until reaching criterion of 10 successive S+ responses without an intervening error. When criterion was reached. the rat was returned to its home cage and the reversal was started 2 days later. Rats were given access to water for 30 min after each session and access for 1 h on the day they were not tested.

After R_2. the rats were randomly divided into treatment groups (drug and control). Drug group rats received an injection of 1.0 mg/kg of methamphetamine 10 min before the start of their reversal. and control Ss received an equivalent volume of saline.

Results

SDR acquisition with 48-h spacing (see Fig. 2) was slower than with 24-h spacing (Fig. 1). Comparison of the control groups for Experiments I and II showed that the 24-h group acquired SDR more rapidly and reached a lower terminal level than the 48-h group. and individual variation was larger with a 48-h than with a 24-h spacing of reversals. A "short-term" drug effect was evident: the drug greatly reduced errors on R_3 and R_4 and reduced the percentage of S+ on R_3. Analyses of variance showed that the groups differed significantly in errors on R_3 and R_4 (F = 13.3. df = 1/14. p < .003; F = 5.6. df = 1/14. p < .032. respectively), but on R_5-R_8 the groups were indistinguishable.

Discussion

The drug markedly affected performance on R_3 and even with the 48 h spacing of reversals. there was a clear effect on R_4. However, the differences between drug and control groups were not large for any reversal after R_4.

GENERAL DISCUSSION

That methamphetamine affects performance in SDR is not in doubt; however the questions of how the drug accomplishes this and what is the duration of the drug effect remain unanswered. The drug obviously reduces errors, even when the percentage of S+ remains unaffected. One can conclude that methamphetamine reduces the probability of making an error in a go/no-go discrimination experiment, either by enhancing discrimination or increasing the aversive consequences of making a nonreinforced response. Studies of shock-punished responding (e.g., Geller & Seifter, 1960) show that amphetamine drugs reduce punished responding. Behaviorally. presentation of an
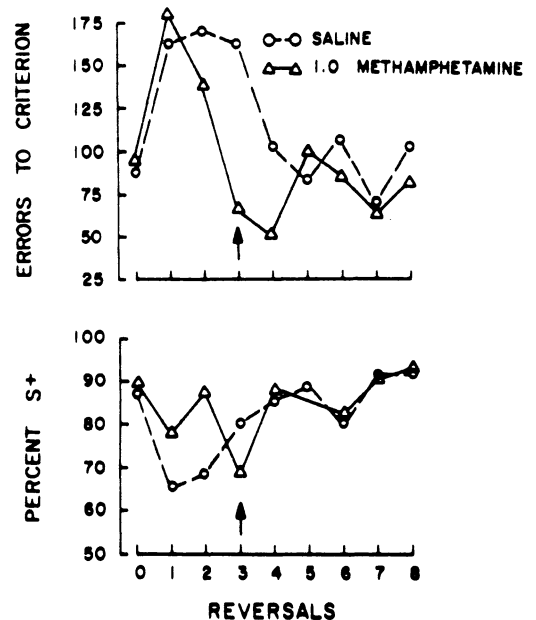

Fig. 2. SDR acquisition with reversals spaced by 48 h for rats injected with saline or 1.0 mg/kg of methamphetamine at Reversal 3 (injection indicated by the arrow). Upper figure shows average errors to criterion. and the lower figure average percentage of S+ trials on which the rats responded. Eight rats per group.

aversive stimulus (e.g., electric shock) and withholding a rewarding stimulus (e.g., nonreward of a leverpress during the S− trial) are both punishment procedures. Since amphetamine drugs reduce shock-punished responding, one might predict that amphetamine drugs also would reduce nonrewarded responding. Thus, one explanation of how methamphetamine affects SDR acquisition is that is reduces the probability of nonrewarded responses (S− responses), thus reducing the number of errors to criterion.

Regarding duration of the drug effect in SDR, any conclusion is tentative. With 0.5 mg/kg of methamphetamine, the drug group performed better than its control group for several reversals after the drug injection (i.e., long-term effect). Yet, in Experiment II, with reversals spaced by 48 h, the drug effect did not persist beyond R_4 (i.e., short-term). Since a "long-term" effect was present with 24-h spacing of reversals, but not with 48-h spacing of reversals, the results suggest that the drug had a residual effect on the performance of the animal which dissipated with time, and when reversals were spaced by 48 h, the drug effect had vanished by R_5.

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Effects of positive and negative requests on compliance following transgression*

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Fifty Ss were assigned randomly to four cells of a 2 by 2 factorial design. Half the Ss were induced to transgress by cheating on a multiple-choice psychology test, while half the Ss did not transgress. Following the transgression manipulation, 28 of the Ss from each of the above conditions were asked to circulate a petition on an issue which was socially desirable while 22 Ss from each condition were requested to circulate a petition on an issue which was not socially desirable. The findings were: (a) the greatest degree of compliance was found in the transgress-socially desirable request group; (b) Ss who had transgressed would not comply to a negative request more than Ss who had not transgressed. Results indicate that greater compliance occurs following transgression if compliance functions to raise self-esteem.

Numerous studies have indicated that transgression leads to an increase in compliant behavior. Transgression has been made operational in a variety of ways, including destroying a machine (Wallace & Sadalla,