Sensory-contingent barpressing for familiar and novel change under a dexamphetamine-amylobarbitone mixture

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In three experiments the effects of administration of Drinamyl (a mixture of dexamphetamine and amylobarbitone in the ratio of 1:6.5 by weight) on responding for novel and familiar sensory change was examined. In the first experiment, an acute administration of Drinamyl enhanced sensory-contingent barpressing (SCBP) with no differential effect for novel vs familiar change. In the second experiment acute Drinamyl also enhanced SCBP, with a larger effect for novel change. In a third experiment the effect of chronic Drinamyl administration was studied. Responding was substantially increased, with responding for sound change showing a greater effect than for light change. Responding for sound change also increased markedly over trials. When the sensory reinforcers were deleted, responding declined. The results were interpreted in terms of an increase in the reward value of SCBP under the drug.

Mixtures of dexamphetamine and amylobarbitone have been found to increase exploratory behavior in novel environments, but with previous experience of the maze, even for only one session, there is a marked reduction in the potentiation of activity by the drug mixture (Steinberg, Rushton, & Tinson, 1961; Rushton, Steinberg, & Tomkiewicz, 1968). Studies of sensory-contingent barpressing (SCBP) have shown that rats will maintain consistent and persistent levels of responding for the same sensory change over large numbers of trials (Sackett, 1965; Glow, 1970; Glow, Roberts, & Russell, 1971). This shows that a sensory change does not have to be novel for SCBP to be reinforcing. The present experiment was designed to investigate the effects of an acute administration of Drinamyl (a mixture of dexamphetamine and amylobarbitone in the ratio of 1:6.5 by weight) on SCBP. A comparison was made of responding under Drinamyl for novel and familiar sensory change. From previous work on exploratory behavior in mazes, it would be predicted that enhanced SCBP would occur when the sensory change was novel, but there would be little or no enhancement for a familiar change.

EXPERIMENT I

One hundred and twelve naive female Wistar hooded rats about 200 days of age were used as Ss. They were tested in single-lever Skinner boxes (see Glow & Russell, 1972, for a full description of the apparatus). The sensory reinforcers were either light onset (a 3.0-sec change from darkness to 71.58 lx) or light offset (a 3.0-sec change from 71.58 lx to darkness). Trials were 20 min, with an intertrial interval of 48 h. All rats were first familiarized to responding for either light onset (56 Ss) or light offset (56 Ss) over 15 trials. On the 16th trial (test trial), each of the onset and offset treatments were divided into four matched groups based on their responding over the previous four trials and according to a 2 by 2 design; Ss on the test trial received either

Drinamyl or placebo and responded for either light onset or offset. Thus, half of the Ss in each treatment responded for a novel sensory change in the form of a light change in the opposite direction to the one they had experienced during the first 15 trials. Injections were made intraperitoneally 20 min before the start of the test trial. The placebo was 1 cc per kilo of body weight of normal saline. Drinamyl solution was prepared to a base of 1 mg dexamphetamine per cc of saline, and the rats were given 1 cc of solution per kilo of body weight. A 17th (posttest) trial was run in which the same conditions applied as on the test trial, except that no drug or placebo was given.

The results for the test trial are presented in Table 1. More responses were made on the test trial under Drinamyl than placebo (F = 17.22, df = 1/48, p < .01). There were no other significant effects. Analysis of the posttest data showed no residual drug effects.

EXPERIMENT II

In the second experiment animals (96 female Wistar hooded rats) were again divided into two treatments and given 15 trials of familiarization to responding for either light onset or light offset. On the test trial, a novel sensory change was introduced to half of the Ss in each treatment by making a sound change the reinforcer. It seems likely that changing the modality of the sensory stimulus would be more novel than switching the direction of light change. The novel change for animals in the light onset treatment was sound onset [a 3.0-sec change from a noise level of 73 ± 1 dB (re 0.0002

Table 1
Mean Number of Responses on the Test Trial: Experiment I

	Light Onset		Light Offset	
	Placebo	Drug	Placebo	Drug
Familiar	24	53	20	43
Novel	17	70	10	52

Table 2
Mean Number of Responses on the Test Trial: Experiment II

Familiar				Novel			
Light Onset		Light Offset		Sound Onset		Sound Offset	
P*	D†	P	D	P	D	P	D
6	31	10	16	15	23	9	64

*Placebo   †Drug

dynes/sq cm) to 86 ± 1 dB by the onset of a buzzer of 133 Hz]: for animals in the light offset treatment, the novel change was sound offset (a 3.0-sec change from 86 to 73 dB by the offset of the buzzer). The sound base level of 73 dB was obtained from a white noise generator. Half of the animals were injected with Drinamyl or placebo on the test trial.

Results

The results for the test trial are presented in Table 2. The test trial data were analyzed by a three-way analysis of variance comparing the effects of (a) familiar vs novel sensory change, (b) direction of sensory change (onset vs offset) and (c) placebo vs Drinamyl. More responses were made for a novel than for a familiar change ($F = 6.54$, df = 1/88, $p < .05$) and under Drinamyl than placebo ($F = 26.16$, df = 1/88, $p < .01$). These results were made more complex by a significant two-way interaction of Familiar vs Novel by Direction of Sensory Change ($F = 7.49$, df = 1/88, $p < .01$) and a three-way interaction of all factors ($F = 12.40$, df = 1/88, $p < .01$). The most prominent aspect of the results contributing to these interactions seems to be the very high number of responses for novel sound offset under Drinamyl. Analysis of the posttest data revealed no residual drug effects.

Discussion

The acute administration of Drinamyl clearly enhanced SCBP. Responding was increased both when the sensory change was novel and familiar. The apparent discrepancy between the present results and those reported for locomotor exploration (Steinberg, Rushton, & Tinson, 1961; Rushton, Steinberg, & Tomkiewicz, 1968) could be due to a number of factors: (a) the fact that novelty in the earlier work referred to a total environment, whereas novelty here was applied to a clearly defined change in one sensory modality; (b) a specific response was used in the present work, whereas a more diffuse response (locomotion) was used in the studies of exploratory behavior; and (c) probably of most importance, the SCBP situation is sufficiently reinforcing to maintain responding over extended periods, whereas exploratory activity in a novel environment typically habituates out quickly. It seems in the SCBP situation of the present experiments

Drinamyl acted directly to enhance the reward value of responding for sensory change rather than by reducing postulated fear or anxiety associated with novelty.

While in Experiment I there was no tendency for Drinamyl to enhance responding more when the sensory reinforcer was novel than when it was familiar, there was evidence that this occurred in Experiment II. However, in the latter case the interaction between Drinamyl and novelty was largely confined to the sound offset change. When the novel change was sound onset, responding under Drinamyl was in fact slightly below the group receiving the familiar light onset change under the drug. Previous research with sound onset and offset (Glow, Roberts, & Russell, 1971) has shown offset to be a much more effective reinforcer than onset. This might account for the present differences between these two changes under Drinamyl.

EXPERIMENT III

The third experiment was conducted to examine the effects of chronic administration of Drinamyl on SCBP. Following the finding of enhanced responding under acute administration, this was intended to provide a more reliable assessment of the effects of Drinamyl on SCBP and an evaluation of the extent to which animals may show tolerance or enhanced reactivity on repeated administration of the drug.

The Ss were 56 naive female Wistar hooded rats about 140 days of age. The sensory reinforcers were light onset and sound offset. The experiment was run in three phases.

Phase 1: Adaptation

Animals were randomly assigned to one of four treatments: (a) operant control (OP), in which barpressing produced no sensory change; (b) sound offset (S), in which animals were reinforced with S for barpressing in a darkened Skinner box; (c) light onset (L), in which Ss were reinforced with light onset; and (d) sound offset plus light onset (S + L), in which leverpressing was reinforced with contemporaneously occurring S and L. A total of 18 trials without any drugs were given in this phase.

Phase 2: Drinamyl

The reinforcement conditions were the same as in Phase 1 and all Ss in each treatment were injected intraperitoneally with Drinamyl 20 min prior to each trial.

Phase 3

Animals continued to be injected with Drinamyl. To assess the role of the response-contingent sensory change in producing the enhanced responding observed in

Fig. 1. Mean number of responses before and after Drinamyl administration for all treatments.

KEY

LIGHT ONSET REINFORCEMENT   o———o   SOUND + LIGHT REINFORCEMENT   o———o

SOUND OFFSET REINFORCEMENT   •———•   OPERANT
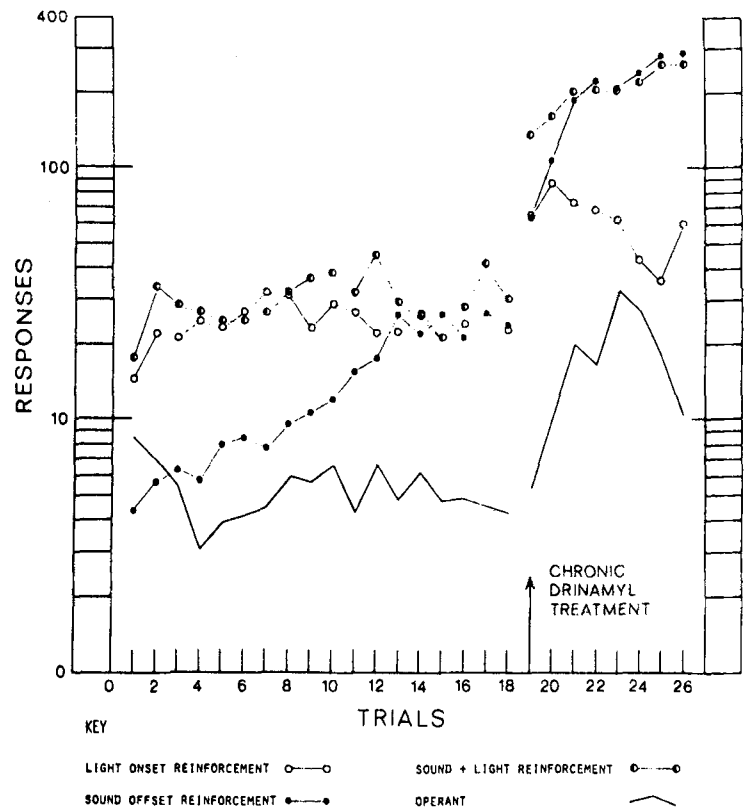
Phase 2, the third phase involved deleting the sensory reinforcers for half of the Ss in each of the S, L, and S + L treatments (Ss were ranked on the basis of their responding over the last three trials on Phase 2 and divided into two matched groups). This phase lasted three trials.

Results

The mean number of responses for all treatments in Phases 1 and 2 are set out in Fig. 1. The data were subjected to a log x + 1 transformation and analyzed by a repeated-measures analysis of variance (Winer, 1970). There were significant differences among the four treatments in Phase 1 (F = 12.75, df = 3/52, p < .01) due mainly to the low level of responding in the OP treatment. The mean number of responses over Trials 14-18 for the OP, S, L, and S + L treatments were 4.0, 23.8, 24.0, and 28.8, respectively. An analysis of these five trials showed no differences among the S, L, and S + L treatments. An analysis of the last five trials of Phase 1 and the first five trials of Phase 2 showed an increase in responding under Drinamyl (F = 18.41, df = 1/104, p < .01). The mean number of responses for the OP, S, L, and S + L treatments over the first five trials of Phase 2 was 16.8, 156.4, 70.2, and 180.2, respectively.

An analysis of all of Phase 2 showed significant differences among the four treatments (F = 20.99, df = 3/52, p < .01). The drug had the greatest effect in

the S and S + L treatments, a less pronounced effect on the L treatment, and least effect on the OP treatment. The main effect for trials was reliable (F = 6.24, df = 7/364, p < .01). However, trends over trials differed between the four treatments (F = 3.95, df = 21/364, p < .01) due mainly to the marked increase in responding over trials in the S and S + L treatments and no such trends in the other treatments.

The mean number of responses for all treatments in Phase 3 is set out in Fig. 2. The main point about these data is that fewer responses were made under the nonreinforcement or extinction condition than when responding continued to be reinforced with sensory change (F = 6.63, df = 1/36, p < .05).

DISCUSSION

The results show a marked increase in responding for a familiar sensory change when Drinamyl was injected for the first time. This confirms the findings of Experiments I and II that a sensory stimulus does not have to be novel before Drinamyl will enhance SCBP. The most noteworthy aspect of the results is that in the S and S + L treatments responding continued to increase over trials when Drinamyl was chronically injected. The eventual mean level of responding in these two treatments was over 250 responses per 20-min trial, with some animals observed to respond over 800 times in a given trial. In a biological sense, these sensory changes are trivial, yet under the influence of the drug the
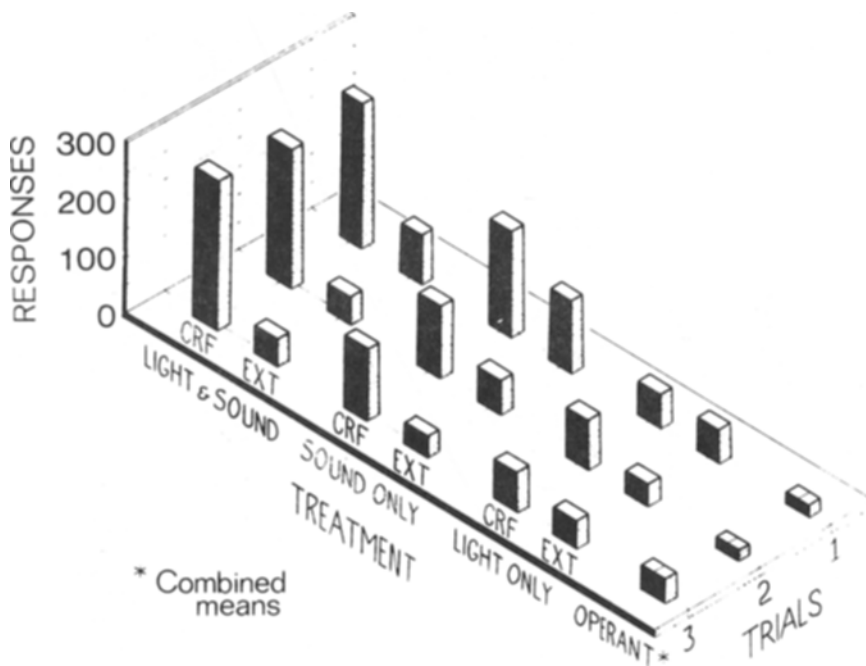
Fig. 2. Mean number of responses as a function of reinforcement vs extinction.

response rate of some Ss approached those that have been obtained with intracranial stimulation (e.g., Olds, 1969).

The difference between the enhancement of responding in the L treatment in comparison to the S and S + L treatments might be consistent with reports suggesting that amphetamine reduces the effects of light stimulation (e.g., Alexander & Isaac, 1965; Isaac, 1971). This warrants further research. The fact that, over trials, animals showed enhanced reactivity when S or S + L was the reinforcer and some tolerance when L was the reinforcer suggests that the effect of chronic drug treatment is mainly a product of drug-reinforcer interaction.

The results of Phase 3, showing an immediate and pronounced decline in responding when the sensory change was deleted, indicate that the enhanced responding under the drug in Phase 2 was not simply due to the drug acting as a psychomotor stimulant. Thus, the enhanced responding seems to be due to an interaction of the drug and the reinforcement mediated by responding for sensory change. Research now needs to be undertaken to study the nature of the enhancing effect of the drug on SCBP and the role of the two components of Drinamyl in raising the level of responding.

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