Determinants of polydipsia: V. Effect of amphetamine and pentobarbital¹

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Abstract

Two rats on free-reinforcement schedules were injected with doses of d,l-amphetamine or pentobarbital sodium just before sessions. Pentobarbital did not much affect frequency of drinks; amphetamine did. Pentobarbital somewhat limited the maximum length of drinks; amphetamine did not. Both drugs increased somewhat the incidence of very short drinks, relative to longer drinks.

Problem

If one of the determinants of excessive drinking on interval dry-food reinforcement schedules is an emotional state produced by having to wait for very small food portions to be doled out at long intervals, one might expect sedative and excitatory drugs to affect differentially the amount of drinking. Falk (1964) found this to be so, but the results were not exactly as expected. Both amphetamine and pentobarbital reduced or abolished schedule-induced polydipsia, although they had opposite effects on home-cage drinking of water-deprived rats: amphetamine reduced drinking, pentobarbital raised it. Here we report data confirming Falk's, and supplying additional details on the effects of the two drugs on drinking behavior.

Method

The procedure has been described previously (Segal et al 1965a, b). Briefly, two adult, male, albino rats, maintained at 80% of ad lib weight, were run on free-reinforcement schedules with inter-pellet intervals of 30-480 sec., in a sound-insulated conditioning chamber containing a food cup, a bar, and a water nozzle, all connected to counters. Five or more sessions at the same F value were run before shifting to another F value or administering drugs. The F values were run in a nonsystematic order: F 60, 90, 30, 90, 30, 60, 90, 120, 240, 90, 480 sec. Drugs were injected, i-p, just before the following sessions: F60, second series, day 6-2 mg/kg d,l-amphetamine; day 10-2 mg/kg Na pentobarbital. F90, third series, day 8-1.5 mg/kg amphetamine; day 11-0.5 mg/kg amphetamine. F120, day 12-1.5 mg/kg amphetamine. F240, day 16-2 mg/kg pentobarbital; day 17-3 mg/kg pentobarbital. Following the drug sessions at F240 there was a session that began with a brief electric shock, and then additional control sessions; during the final F90 series additional treatments were tried, including extinction with and without empty pellet dispenser operation, free-feeding in the conditioning chamber, and another shock session. Extinction data are in Segal et al (1965a);

Table 1. Drink durations with frequency $\geq 10\%$ of all drink durations

	0-2		BC-1	
	Last pre-drug day	Drug day	Last pre-drug day	Drug day
Amphetamine				
0.5 mg/kg F90(3rd)	10-70	2-60	2-80	2-70
1.5 mg/kg F90(3rd)	*	2-70	*	2-50
1.5 mg/kg F120	10-80	2-80	10-80	2-100
2.0 mg/kg F60(2nd)	no data	no data	no data	no data
Pentobarbital				
2 mg/kg F60(2nd)	20-50	2-30	30-50	2-20
2 mg/kg F240	2-120	2-120	2-100	2-80
3 mg/kg F240	*	2-120	*	2-40

* Same baseline as line directly above.

control data at all F values are in Segal et al (1965b).

Next, Ss were placed on a feeding schedule that permitted them to eat most of the day, but found them without food in the cage on the following morning. Water consumption was measured for the first hour following replenishment of the daily food supply, while the Ss were presumably eating; on day 5 of this regimen, 4 mg/kg pentobarbital were injected just before the hour of water-consumption measurement began. Next, Ss were placed on a 23-hr. water-deprivation schedule, and water consumption during 1-hr. daily watering was recorded; on day 4, 3 mg/kg pentobarbital were injected just before watering.

Results

Table 1 shows the range of drink durations that included the shortest drinks that occurred with frequency $\geq 10\%$ of all drinks, and the longest drinks with frequency $\geq 10\%$ of all drinks. Data appear for the final day prior to any drug injections at that F value, and, separately, for drug days. Amphetamine had variable effect on the length of longest drinks, decreasing it in 1 out of 3 drug runs for which data are available, in 0-2, and 2 out of 3, in BC-1, but increasing it in 1 out of 3, in BC-1. Amphetamine increased the relative contribution of very short (2 sec.) drinks to total drink frequency (3 of 3, 0-2; 1 of 3, BC-1). Pentobarbital had no effect at all on the range of drink durations contributing at least 10% of drinks, in 2 out of 3 runs, in 0-2; it decreased the length of longest drinks in 1 out of 3, 0-2, and 3 out of 3 runs, BC-1; and it increased the relative contribution of very short drinks, in 1 out of 3 runs of 0-2 and BC-1.

Table 2 shows the per cent of inter-pellet intervals that included a drink, in the last 2-3 days prior to a given drug injection, and in the drug session. Because

Table 2. Per cent of inter-pellet intervals with drinks

	0-2		BC-1	
	Last 3 pre-drug days (means & range)	Drug day	Last 3 pre-drug days (means & range)	Drug day
Amphetamine				
0.5 mg/kg F90*	84.6(79-90)	66	37.0(36-38)	18
1.5 mg/kg F90	87.6(82-93)	17	40.0(32-50)	12
1.5 mg/kg F120	89.6(83-96)	36	33.3(29-41)	7
2 mg/kg F60	87.0(86-94)	5	31.0(29-32)	10
Pentobarbital				
2 mg/kg F60	77.6(70-84)	53	20.6(24-19)	24
2 mg/kg F240	46.6(43-49)	40	43.0(37-47)	42
3 mg/kg F240**	46.6(43-49)	40	43.0(37-47)	38

* 2 pre-drug days only.

** Followed 2 mg/kg pentobarbital directly; same baseline.

the pre-drug days are somewhat variable, Table 3 is included. It shows the ratio of the lowest pre-drug drink per cent to the highest pre-drug drink per cent over the 2-3 days pre-drug, as well as the ratio of the mean pre-drug drink per cent to the drug drink per cent. Thus, the lowest drink per cent in 3 pre-drug days preceding amphetamine 2 mg/kg at F60 in 0-2 was 81% of the highest drink per cent over the same 3 days; on the other hand, the percent of inter-pellet intervals that included drinks on the drug day was only 6% of the mean drink per cent in the preceding 3 days. Comparison of the 2 columns of data for 0-2 shows that no dose of pento-

Table 3. Drug effect relative to baseline variability: Per cent of intervals with drinks

	0-2		BC-1	
	Last 3 pre-drug days: min./max.	Drug day + pre-drug days: mean pre-drug	Last 3 pre-drug days: min./max.	Drug day + pre-drug days: mean pre-drug
Amphetamine				
0.5 mg/kg F90*	.88	.78	.95	.49
1.5 mg/kg F90	.88	.19	.64	.30
1.5 mg/kg F120	.86	.40	.71	.21
2 mg/kg F60	.81	.06	.91	.32
Pentobarbital				
2 mg/kg F60	.83	.68	1.13**	1.12
2 mg/kg F240	.88	.86	.79	.98
3 mg/kg F240***	.88	.86	.79	.88

* 2 pre-drug days only.

** Max./min. instead of min./max., to correspond to increase on drug day.

*** Followed 2 mg/kg pentobarbital directly; same baseline for both.

barbital had an appreciable effect on drink frequency, but 1.5 mg and 2.0 mg doses of amphetamine markedly reduced drink frequency. Similar results occurred for BC-1.

In short, pentobarbital somewhat shortened drinks but did not affect their frequency. Amphetamine reduced the frequency of drinks, did not affect the maximum length attained by a drinking episode, but increased the relative number of very short drinks.

Pentobarbital injections during home cage drinking confirm Falk's (1964) report that the drug increases water consumption slightly. On free food and water, pentobarbital 4 mg raised 1-hr. consumption from about 10 ml to about 17 ml in BC-1, and from about 8 ml to about 12 ml in 0-2. On free food and restricted water, pentobarbital 3 mg/kg raised water consumption in 1 hr. from about 30 ml to about 35 ml in BC-1, and from about 25 ml to about 27 ml in 0-2 (the last does not appear to be a significant effect). We did not check the effects of amphetamine on home-cage drinking, because its effect—reduction of water consumption—has been widely reported.

Discussion

Pentobarbital did not raise drinking during F schedule sessions; it did raise drinking in the home cage. It may have reduced session drinking very slightly, but not enough to justify the conclusion that session polydipsia reflected an emotional state depressible by a sedative. Amphetamine drastically reduced session drinking, not supporting the hypothesis that session polydipsia reflects an emotional state enhanceable by a sympathomimetic excitatory drug. Since amphetamine depresses even home-cage drinking, its use to test the hypothesis that polydipsia is an indirect effect of an emotional state of a sort that should be facilitated by sympathomimetics is questionable. We plan to test the effects on polydipsia of other excitatory drugs.

References

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Note

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