Original Investigations

Selective Increase in Avoidance Responding by Methamphetamine in Naive Rats *

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Abstract. Avoidance responses, extra responses (on avoidance lever) and wrong lever responses were measured in naive rats acquiring a discriminated avoidance in a 2 lever Skinner box, 30 min after methamphetamine (0.25, 0.5 and 1.0 mg/kg). The smallest dose was ineffective; 0.5 and 1.0 mg/kg significantly increased the number of avoidance responses. This increase was not associated with a significant increase in the two other responses studied. The progressive increase (from the first to second part of the acquisition session) in avoidance responses was not accompanied by a parallel increase in the other responses. The position discrimination and the discrimination of the presence or absence of the conditioned stimulus was observed to be better in the drug groups.

Key words: Avoidance and Acquisition — Methamphetamine — Discrimination Learning — CNS Stimulants — Rat.

Introduction

Amphetamines are claimed to enhance acquisition of new behavior in animals (Belleville, 1964; Domino, Caldwell and Heinke, 1965; Kulkarni and Job, 1967; Verhave, 1958). Amphetamines enhance avoidance performance in normal animals (Hearst and Whalen, 1963) as well as in "poor" performers (Rech, 1966). They increase somatic motor activity (SMA) (Novelli and Tainter, 1943; Dews, 1953) and intertrial hurdle crossings (IHC) in a two-way avoidance learning (Powell et al., 1965; Bovet and Gatti, 1965). Therefore it seems possible that the stimulant drugs like amphetamine produce an increase in "all" responses. Since amphetamines are known to increase bar press responding in multiple schedules (Bignami and Gatti, 1969) as well as DRL (differential reinforcement of low rate) schedules (Kelleher et al., 1961; Weiss and Laties, 1964) one may propose that the enhancement of acquisition of a bar-press avoidance is merely the reflection of increased probabilities of all responses, some of which happen to be avoidance responses.

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Other evidence available in the literature does not completely agree with the above proposal. For example, after amphetamine, exploratory activity (in response to environmental stimuli) was found to be decreased; however, simultaneously measured SMA had increased (Wakely and O'Sullivan, 1969). Divergence in various kinds of locomotor activities after CNS stimulants was pointed out by Marriott (1968) who found that amphetamine and caffeine, in doses sufficient to increase locomotor wheel activity, did not increase locomotion in a novel Y-maze. Amphetamine did not increase bar press responding in non-CS periods (Hearst and Whalen, 1963). On the other hand, amphetamine decreased operant performance on a CRF-EXT (continuous reinforcement-Extinction) schedule (Cole, 1968, 1969).

Powell et al. (1965) found no enhancement of avoidance learning despite the increase in IHC. Amphetamines did not increase operant levels of responding (Verhave, 1958). Therefore, it may be concluded that the observed effects of amphetamines on various "acquisition" paradigms were not uniform, neither were the effects on spontaneous behavioral responses similar to the effects on performance using various schedules and reinforcers (Kelleher and Morse, 1964; Ferster, Appel and Hiss, 1962; Clark and Steele, 1966; Dews, 1958; Cole, 1967). For a given schedule, nonspecific effects of the drug should preferably be measured simultaneously with the specific responses during acquisition, thus providing direct and meaningful comparison.

The present report concerns methamphetamine. Its effect in the rat is examined on acquisition of bar-press avoidance and on other simultaneously measured bar presses that have no effect on the shock. The changes in the frequency of the bar-press avoidance and that of other nonspecific responses were found not to be parallel to one another as training proceeded in a Skinner box after the injection of drug.

Methods

Avoidance training was given to naive adult male rats, of Harlan-Wistar strain, according to a method described by Hurwitz (1964) and later modified (Kulkarni, 1968). Three doses of methamphetamine hydrochloride (0.25, 0.5 and 1.0 mg/kg) or saline (1ml/kg) were administered intraperitoneally. Each animal was isolated in a single cage after the injection and 30 min later was placed in the Skinner box (2 lever, Lehigh Valley Electronics). Initial experiments indicated that enhancement of avoidance learning could be clearly demonstrated within 400 trials given in a single session. Each trial consisted of 15 sec of conditioned stimulus (CS-light and white noise) ending with a brief (0.5 sec, 1.6 mA) shock. The cycle was immediately repeated when no response occurred.