Psychopharmacology 53, 207–209 (1977)

Psycho-
pharmacology

Dose-Response Effects of Taurine on Some Open-Field Behaviors in the Rat

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Abstract. In two experiments albino rats were injected i.p. with various doses of taurine and their subsequent behavior in an open-field apparatus was observed. Increasing doses of taurine significantly decreased ambulation levels, increased latency scores, and increased thigmotaxis ('wall-hugging' behavior). In general, 50 mg/kg or more of taurine was required to produce significant changes in the dependent behavioral measures. The open-field behaviors of rearing and defecation were not significantly affected by the drug manipulation. The results of these experiments suggest that taurine may act as modulating or stabilizing agent in the central nervous-motor system rather than as a diffuse inhibitory agent.

Key words: Taurine – Open-field behaviors – Dose-response effects – Rats

The significance of taurine (2-aminoethanesulphonic acid) in nervous tissue is still not known with certainty. Behaviorally, i.p. injections of taurine (0.3–3.0 mg/kg) have produced a dose-dependent depression of habituated psychomotor activity in rats (Baskin et al., 1974). In mice, i.p. injections of large amounts (9–21.3 mmole/kg) of this amino acid resulted in decreased locomotor activity and decreased instrumental responding for food or water (Hruska et al., 1975). Intraventricular taurine administration also decreased locomotor activity and licking and grooming behavior in rats (Barbeau et al., 1975; Sgaragli and Pavan, 1972). Recently Persinger et al. (1976a) demonstrated that taurine (62.5–125 mg/kg) administered i.p. to postnatal-preweaning rats can have weak inhibitory behavioral effects on adult motoric behavior.

The present experiments investigated the effects of several dosage levels of taurine on a number of behaviors occuring in a novel open-field situation (for a review of the open-field test see Walsh and Cummins, 1976). The use of this multi-index open-field method allows one to construct a behavioral profile consequent to the drug manipulation (cf. Drew et al., 1972). Then, by comparing the effects of taurine upon the various behaviors measured, one could determine if this amino acid acts chiefly as a general inhibitory agent (by depressing all behaviors involving motor components and/or by increasing such autonomic responses as defecation), or as a more selective modulator or stabilizer in the CNS (by affecting only some of the behaviors).

MATERIALS AND METHODS

Thirty-five male albino Wistar rats (Woodlyn Laboratories) were used in Experiment 1 and 40 male rats in Experiment 2. Subjects weighed 450–500 g and 300–375 g, respectively, at the start of the experiments. Subjects in the first experiment had previously been used in a taste-aversion learning study involving an injection of LiCl. Subjects in Experiment 2 had been previously used in a learning study involving alleyway training to food reinforcement. Prior to the runway experiment, these animals were handled daily for 2–3 min over a 2-week period. More than 2 months elapsed between the taste-aversion study and Experiment 1, and 6 weeks between the alleyway study and Experiment 2. All subjects were individually housed, kept on a 12-h light-dark cycle (lights on 7.00 a.m. to 7.00 p.m.) and given ad lib. access to food and water during the experimental procedures described here.

Subjects in Experiment 1 were randomly assigned to 3 groups of 9 rats and one group of 8 rats. These groups were injected i.p. with saline, 3.0, 50.0, or 100.0 mg/kg of taurine. In the second experiment the rats were randomly assigned to 5 groups (8 rats/group) and injected i.p. with saline, 25.0, 50.0, 75.0, or 200.0 mg/kg of taurine. In both experiments the injection volume was 2 ml/kg.

After the injection each rat was coded and put back into its home cage for 1 h before being tested in the open-field apparatus.

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The open field was circular (85 cm diameter) and surrounded by a wall 30 cm high. The arena was flat black and the floor was marked off in 3 concentric circles and divided into 19 equal area segments. Five 100-W light bulbs 125 cm above the field provided illumination and the ambient noise level at field level was 55 ± 0.5 db. The open-field test was 3 min in duration and 4 behavioral measures were recorded: the latency to leave the initial square, the number of squares entered by the four paws of the rat, the number of rearing responses (lifting front paws off the floor and standing on hind legs), and the number of fecal boluses deposited in the arena during the test period. After removing the animal from the apparatus, the floor was sponged over with a weak vinegar solution to mask any residual odors. This procedure was repeated on 3 consecutive days. The subjects were run under a blind procedure so that the experimenter recording the open-field measures was unaware of the group designation of any given animal. Before data analyses were done, the latency measure was converted to a latency score by taking the reciprocal of the latency time. In addition, a thigmotaxis ratio (a measure of the 'wall hugging' behavior) was calculated by dividing the number of times a square in the inner two circles of the arena was entered by the total number of squares entered.

RESULTS

Each dependent variable was analyzed with a repeated measures design analysis of variance with the significance levels set at the 0.05 level of confidence. Post-hoc multiple comparisons were made with the Duncan multiple range test.

Figure 1 shows that increasing doses of taurine produced a decrement in ambulation in both experiments. Statistically, there were significant group differences in both Experiments 1 and 2 ($F = 4.067$, $df = 3/31$, $P < 0.025$ and $F = 2.738$, $df = 4/35$, $P < 0.05$, respectively). Post-hoc comparisons indicated that the 50 mg/kg group was significantly less active than the saline or 3 mg/kg groups in the first experiment and that both the 50 and 200 mg/kg groups were less active than the saline or 25 mg/kg groups in Experiment 2.

Significant group differences in latency scores were also found in both experiments ($F = 5.196$, $df = 3/31$, $P < 0.01$ and $F = 7.137$, $df = 4/35$, $P < 0.001$, respectively). In Figure 1 it can be seen that a decrease in the speed of leaving the initial square was a function of increasing taurine dosage level. Post-hoc tests showed that the 50 and 100 mg/kg groups were significantly slower than the saline or 3 mg/kg groups in Experiment 1, and the 50, 75, and 200 mg/kg groups were slower than the saline and 25 mg/kg groups in Experiment 2.

There were no significant group differences for the thigmotaxis ratio in Experiment 1 (possibly due to a large number of zero scores in the data), but in Experiment 2 the groups main effect was significant ($F = 2.931$, $df = 4/35$, $P < 0.05$). The multiple range test showed significantly less thigmotaxis for the saline and 25 mg/kg groups relative to the 75 and 200 mg/kg groups (see Fig. 1). In neither experiments were there any significant main effects or interactions for the rearing and defecation measures.

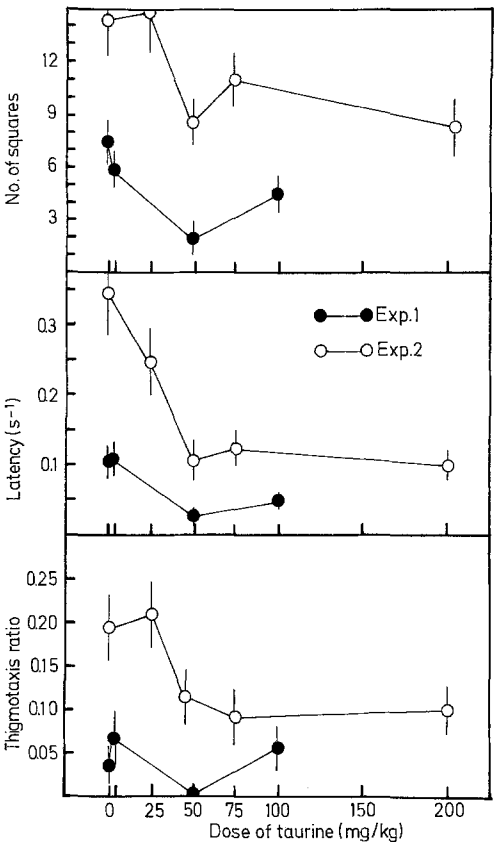

Fig. 1. Mean ambulation scores (*top panel*), latency scores (*middle panel*), and thigmotaxis ratios (*bottom panel*) as a function of taurine dose levels injected. Values for the first experiment are represented by the closed circles; for the second experiment by open circles. Error bars represent standard errors

DISCUSSION

The present findings of decreases in ambulation resulting from increases in taurine injection levels is consistent with previous reports (Baskin et al., 1974; Barbeau et al., 1975; Hruska et al., 1975). Interestingly, no effects of taurine injections were found for the rearing measure. Ambulation and rearing responses are assumed to be two mutually exclusive motor responses (cf. Walsh and Cummins, 1976). The finding that taurine has an effect on only one of these motor behaviors seems to argue that taurine may not simply be a wide spectrum inhibitory agent, but rather may play a more selective role as a modulator or stabilizer in the CNS-motor systems. The failure to find significant effects of taurine on emotional behavior

(i.e., defecation) is also consistent with other studies (Persinger et al., 1976b). Our results suggest that a detailed study of the effects of taurine on the motor behaviors of rats in the open-field situation might provide some clues to the role of taurine in the CNS.

Acknowledgement. This research was supported by a National Research Council of Canada grant to Dr. N. I. Wiener and by a National Research Council of Canada Postgraduate Scholarship to the second author. We would like to thank D. Corey for technical assistance and Dr. M. A. Persinger for critical remarks about an earlier draft of this paper.

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Received October 5, 1976; Final Version February 3, 1977