EFFECTS OF PANAX GINSENG ROOT ON ACQUISITION OF SOUND DISCRIMINATION BEHAVIOUR IN RATS

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Abstract—Pole-climbing and shuttle-avoidance tests were employed to study the acquisition of conditioned avoidance response (CAR) and discrimination behaviour (DB) in male Wistar rats which had been given extracts from Panax Ginseng root intraperitoneally or orally. Neither a lipid soluble fraction (GNo. 5) nor a ginsenoside Rg fraction (GRg) produced significant changes in the acquisition of CAR. GRg given intraperitoneally produced a significant acceleration in the acquisition of DB between a 500 Hz signal sound followed by an electric shock (SD) and a 1000 Hz signal sound without a shock (SJ) in rats which had learned to avoid the shock following S1 at a rate of over 95%. Small doses of GNo. 5 produced a significant depression in the acquisition of DB.

Several authors (1—3) have reported the central nervous system (CNS) stimulating activity of Panax ginseng root. The existence of CNS-stimulating substances is also assumed for fractions of Panax ginseng root, such as the saponin fraction (ginsenoside Rg) and lipid soluble fraction (GNo. 5), from the results of blind screening (4). Ginsenoside Rgl, the main component of ginsenoside Rg fraction (GRg), accelerated the recovery from the fatigued states in the mice exposed to 4 hr oscillation (5). This may be an indication of CNS-stimulating activity. Data on the CNS-stimulating activity of both fractions by blind screening were compared with those of known CNS-stimulants, but drugs showing similar neuropharmacological spectra were not found. Interpretation of their possible pharmacological properties was then attempted. GRg and GNo. 5 produced a slight shortening of the response latency (RL) to the conditioned stimulus (CS) in the pole-climbing and shuttle-avoidance tests, and GNo. 5 disrupted the discrimination of sound stimuli in the avoidance situation (6). The purpose of the present study was to investigate the possible influence of GRg and GNo. 5 on acquisition of CAR and of sound discrimination behaviour (DB) in the pole-climbing and shuttle-avoidance situations.

MATERIALS AND METHODS

1) Pole-Climbing Test

The experimental details of the apparatus and the procedure of training were as reported in our previous report (6).
Experiment 1: Sounds of 500 Hz, which occurred intermittently once a sec and were 0.5 sec in duration, were delivered for 20 sec as CS; the stimulus consisted of sounds only for the first 10 sec and then sounds followed by electric shocks (unconditioned stimulus, 0.1 mA, 35 V, AC) for the remaining 10 sec. This training situation was repeated 10 times during an interval of 2 min per session. Groups of 10 male Wistar rats (6-7 weeks old) weighing 150-170 g were given each drug and their training carried out in 2 sessions per day at 20 and 100 min after the injection for a week.

Experiment 2: Trained rats which were able to avoid shock stimuli of 500 Hz sounds (CS) at the rate of over 95%, were trained to discriminate between sounds of 500 Hz (SD) which were followed by electric shocks and those of 1000 Hz (S') which were not followed by electric shocks. The animals were exposed to both SD and S' alternately at intervals of 2 min for 40 min a day, at the same time day for 3 consecutive days. This procedure was started from 5 min after the injection of the drugs.

Experiment 3: Trained rats as in experiment 2, were exposed to 5 trials of SD and those of S' by turns for 40 min a day, at the same time of day for 7 consecutive days. This procedure was started from 5 min after the injection of drugs.

2) Shuttle-Avoidance Test

The experimental details of the apparatus and the procedure of the training were as described in the previous paper (7).

Experiment 4: Experiment 4 was designed the same as experiment 1 except for the test apparatus and the interval of training (1 min). Rats in groups of 8 were used.

Experiment 5: Naive rats were trained to discriminate between the sounds of 500 Hz (SD) and those of 1000 Hz (S'). They were exposed to 10 trials of S' at an interval of 1 min, and then for 5 min without either stimulus. Ten trials of SD were then delivered at intervals of 1 min, and after a following 5 min period of no stimulus, trials of S' were started again. The rats were exposed to this situation for 1 hr a day, at the same time of day for 3 consecutive days, 20 min after the administration of drugs.

Experiment 6: Trained rats (7) which had attained a 95-100% performance level of the CAR, were exposed to SD and S' alternately an intervals of 1 min for 40 min a day, at the same time of day, for 3 consecutive days. This procedure was started at 30 min after the administration.

3) Rotating rod and Suspension Tests

The rotating rod and suspension tests were performed to confirm the dose of drugs which produced motor incoordination and/or muscle relaxation. The rats were tested 4 times: 10, 40, 70 and 100 min after the i.p. administration, at the same time of day for 7 consecutive days, and 3 times: 40, 70 and 100 min after the p.o. administration for 12 days.

4) Drug Tested

GRg and GNo. 5 from Panax ginseng root were used. A detailed fractionation of these compounds has been described in our previous report (6). GNo. 5 was separated into alkaline-soluble (GNo. 5-1) and -insoluble (GNo. 5-2) fractions. GNo. 5, GNo. 5-1 and GNo. 5-2 were suspended in physiological saline with tween 80. The solution of GRg
was prepared with physiological saline. Methamphetamine hydrochloride (MA) and eserine sulfate (ES) were used as controls. Drugs were given once a day at the same time of day, each day preceding the test. GRg, GNo. 5, GNo. 5-1 and GNo. 5-2 in doses of 10 and 30 mg/kg were given i.p. in the pole-climbing test. But in the shuttle-avoidance test they were given p.o. from 5 days before the test. MA in doses of 0.5 and 1 mg/kg and ES in doses of 0.03 and 0.1 mg/kg were given i.p. in both tests. Student's t-test was used in every experiment for statistical assessment.

RESULTS

Experiment 1: No fractions or drugs produced significant changes as compared with the control in the acquisition of CAR. GRg in doses of 10 and 30 mg/kg, MA 1 mg/kg and ES 0.1 mg/kg produced a slight acceleration of the acquisition of CAR in the second session of the first experimental day and in the first or second session of the second experimental day, but this was not statistically significant.

Experiment 2: In the case of 10 mg/kg of GRg, the number of trials in which a rat did not climb to S4 was significantly larger than that in the control on the second experimental day (Fig. 1), but the climbing response to S10 was not affected. GRg, 30 mg/kg also produced a similar effect, but it was not statistically significant. MA, 1 mg/kg produced a significant increase in the climbing due to S4, GNo. 5 and ES had no effect on DB to either S10 or S4, though GNo. 5 in doses of 10 and 30 mg/kg produced a slight but not significant increase in S4 climbing.

Experiment 3: The effects of GRg, GNo. 5, GNo. 5-1, GNo. 5-2, MA and ES on the acquisition of DB in trained rats were observed repeatedly using a different procedure from that in experiment 2. In the test using 10 mg/kg of GNo. 5 and GNo. 5-1, the number of climbings up the pole by S4 increased significantly in the 3rd and 4th days (Fig. 2). No
The results of the rotating rod and suspension tests indicated that these fractions had no influence on motor coordination or muscle tone, at least in the above mentioned doses.

DISCUSSION

The effects of ginseng extract fractions and drugs on the acquisition of CAR were studied in the pole-climbing (Experiment 1) and shuttle-avoidance (Experiment 4) tests. No fraction or drug produced any significant change.

The effects of drugs on the acquisition of DB in the rats which had learned to avoid shock following signal sounds of 500 Hz at the rate of over 95% were also studied using the
pole-climbing (Experiment 2 and 3) and shuttle-avoidance (Experiment 6) tests, and also on the acquisition of DB in the naive rats using the shuttle-avoidance test (Experiment 5). GRg produced a significant increase in the acquisition of DB in experiment 2. To obtain the same effect on the acquisition of DB as shown in experiment 2, experiment 3 was performed using a different arrangement between S0 and S'. GRg produced a slight but not significant increase in the acquisition of DB. GRg given p.o. in the shuttle-avoidance test (Experiments 5 and 6) did not produce any significant change in the acquisition of DB. These results indicate that the absorption rate of GRg given p.o. is low and that GRg produces increased alertness or influences the process of learning.

GNo. 5, 10 mg/kg produced a significant depression in the acquisition of DB by S' in experiments 3 and 6, but not in experiments 2 and 5. The effects of GNo. 5 were similar to those of MA in experiments 3 and 6 but not in experiments 2 and 5. This may indicate that GNo. 5 in smaller doses produces an increased alertness not stronger than MA. In experiment 2, the effect of GNo. 5-1, an alkaline-soluble fraction from GNo. 5, was similar to that of GNo. 5. This means that CNS-stimulant activity in GNo. 5 is caused by GNo. 5-1. From these results, it is estimated that two different types of CNS-stimulant activity are contained in ginseng.

The effect of the amphetamines on learning behaviour has been reviewed by Dews and Morse (8). A number of workers have reported that amphetamine facilitated escape response, conditioned avoidance response and discrimination learnings in animals but impairment was seen when larger doses were given (9, 10, 11, 12). In our experiments, MA did not produce an acceleration of the acquisition of CAR and DB in the pole-climbing and shuttle-avoidance tests. On the other hand, MA 1 mg/kg produced a significant inhibition of the acquisition of DB to S' in experiments 2, 3, 5 and 6. There is no doubt that under some circumstances, impairment in performance and acquisition of DB by methamphetamine would be due to increased alertness or motivation. The failure in acquisition of DB by MA in 4 experiments would also be the result of increased alertness since programs on acquisition of DB in these 4 experiments were more complicated and included aversive stimuli. Although several studies have indicated that physostigmine inhibited the performance of conditioned avoidance behaviour (13, 14, 15), smaller doses of physostigmine has been shown to enhance discrimination learning (16, 17, 18, 19, 20). In every experiment herein, ES produced no significant changes in the acquisition of DB.

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REFERENCES


