EFFECT OF DRUGS ON DOMINATION-SUBORDINATION RELATIONSHIPS IN PAIRS OF RATS

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The effect of neuroleptics (chlorpromazine, trifluoperazine, haloperidol), antidepressants (amitryptiline, imipramine), tranquilizers (diazepam, chlordiazepoxide, benactyzine), and the stimulant amphetamine on domination-subordination relationships established as a result of competitive behavior in pairs of rats was studied. These drugs were shown to disturb the established relationships between domination and subordination, to impair the ability of the dominant rats to attack and to improve the ability of the subordinate rats to defend themselves. With an increase in the doses of antidepressants administered to the subordinate rat its ability to behave competitively was improved, and this could lead to a switch of domination.

KEY WORDS: domination; subordination; psychotropic drugs.

Hierarchical relationships within the group in herd animals are one of the decisive factors in their behavior [1]. The results of such relationships may also lead to changes in the action of drugs on individual members of the group [2]. The study of the effect of drugs administered under conditions of intragroup behavior thus gives a more complete picture of their spectrum of action.

With these facts in mind it was decided to study the effect of various classes of psychotropic drugs on domination-subordination relationships, the basis of intragroup behavior.

EXPERIMENTAL METHOD

Experiments were carried out on 500 male Wistar albino rats weighing 180-200 g kept in a tank with a base 32 cm in diameter. The temperature of the water in the tank was 20°C and of the surrounding air 23°C. In the center of the tank a round vertical pillar 4 cm in diameter rested on the base and projected above the surface of the water by 1 cm (Fig. 1).

The rats were initially placed in the tank one at a time so that they could learn the avoidance reaction of mounting the column, after which they were placed in the tank in pairs for 30 min. The number of attempts made by each animal to push its companion off the column and the number of successful pushes were recorded. The ratio between the second and first numbers was defined as the effectiveness of attempts to push (EAP). After 20 min the victorious rat was removed from the tank for 1 min to allow the vanquished rat to occupy the column again, after which the victor was replaced for a further 10 min (control pushing) in order to discover whether this rat was in fact the victor or whether it had accidentally occupied the column first without resistance from its companion. After the end of the experiment the victorious and vanquished rats were returned to their cage for 24 h, when the experiment was repeated.

EAP for the victorious and vanquished rats was calculated on the first and second days and the number of changes of the victor was counted on the second day. The number of situations on the second day when there was no competition for the dry area, i.e., when the rat which first mounted the column, regardless of whether on the first day it had been victor or vanquished, was not attacked by its companion, and during the period of control pushing itself made no attempt to occupy the dry area, also was taken into account.

The drugs were injected intraperitoneally 30 min before the beginning of the experiment in the following doses (in mg/kg): chlorpromazine 0.5 and 1.0, trifluoperazine 0.25 and 0.5, haloperidol 0.25 and 0.5, diazepam

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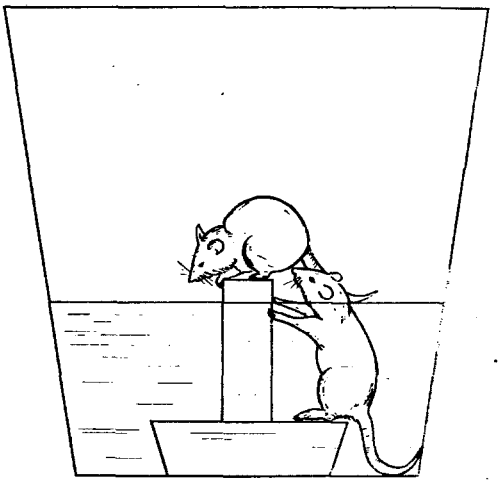

Fig. 1. Scheme of experimental tank. Dominant rat sitting on column and subordinate rat immersed in water can be seen.

0.15 and 0.5, chlordiazepoxide 1.5 and 5.0, benactyzine 0.4 and 0.8, amitryptiline 0.5 and 1.5, imipramine 0.15, 0.3, and 2.5, and amphetamine 1.0.

The results were subjected to statistical analysis by means of Meddis' nonparametric criterion of difference [3].

EXPERIMENTAL RESULTS

When two rats were placed in the tank of water with a dry area large enough for only one animal, energetic competition began, as the result of which the vanquished rat ceased to claim the dry area on the column occupied by the victorious rat. When the rats were replaced in the tank after 24 h, the rat defeated on the first day only occasionally made feeble attempts to displace the victorious rat. The value of EAP for the victorious rat was much higher than that for the defeated rat, and also much higher than its own EAP on the 1st day ($P < 0.01$). In this situation, domination-subordination relationships were thus formed as a result of competitive behavior, with the result that after 24 h the number of attempts by the defeated rat to occupy the dry area was significantly smaller than on the first day ($P < 0.05$).

The ability of the defeated or, as it should be called on the second day, the subordinate rat to behave competitively was reduced not only with respect to its own companion, but also relative to a control rat, for when placed in the tank together in 86% of cases the control rat proved to be the victor ($P < 0.05$), and in 14% of cases there was no competition for the dry area, and the rat which first occupied the top of the column was virtually not attacked by its companion, and in the control pushing period made no attempt itself to occupy the dry area. When pairs of rats consisting of victorious and control animals were placed together in the tank on the second day the pattern of their mutual behavior resembled the competitive behavior of the control rats, and the distribution of victories was indistinguishable from random ($P > 0.05$).

The effect of drugs was studied using this model of domination and subordination. When chlorpromazine 0.5 mg/kg, haloperidol 0.25 mg/kg, diazepam 0.15 and 0.5 mg/kg, chlordiazepoxide 1.5 and 5 mg/kg, amitryptiline 1.0 and 5.0 mg/kg, and imipramine 0.3 mg/kg were injected into the dominant rat, the characteristic increase in its EAP, evidence of establishment of domination-subordination relationships, was not observed. If the doses of these neuroleptics were doubled, and also after administration of trifluoperazine 0.25 and 0.5 mg/kg and imipramine 2.5 mg/kg in some cases the roles of victor and vanquished were exchanged. Situations also arose when there was no competition for the dry area, and the rat which occupied the top of the column first was virtually not attacked by its companion, and during the control pushing stage itself made no attempt to occupy the dry area. It can thus be concluded that these drugs, if given to the dominant rat, reduced its ability to attack.

After administration of chlorpromazine 1 mg/kg, trifluoperazine 0.25 and 0.5 mg/kg, haloperidol 0.25 and 0.5 mg/kg, diazepam 0.15 and 0.5 mg/kg, benactyzine 0.4 and 0.8 mg/kg, amitryptiline 1 mg/kg, and imipramine 0.15 and 0.3 mg/kg to the subordinate rat EAP remained unchanged, but the characteristic increase

in EAP of the dominant rat likewise was not observed in this case, suggesting that the ability of the subordinate rats to defend themselves was increased. Amitryptiline 5 mg/kg and imipramine 2.5 mg/kg, if given to the subordinate rat, led to a decrease in EAP of the dominant rat. Meanwhile, after administration of amitryptiline in a dose of 5 mg/kg to the subordinate rat, in some cases the role of victor was exchanged, and in this case EAP of the subordinate rat was increased. It can accordingly be concluded that antidepressants, in the above-mentioned doses, not only increase the ability of the subordinate rat to defend itself, but may also strengthen its ability to attack, an effect seen particularly clearly after administration of amitryptiline. In experiments in which the drugs were given to both rats, the characteristic increase in EAP of the dominant rat likewise was not observed, but in some cases (after administration of 0.5 mg/kg trifluoperazine and 0.25 and 0.5 mg/kg haloperidol) the roles of victor and vanquished were reversed or competition for the dry area ceased. In some cases there was a sharp decrease in EAP of the dominant rat. This evidently took place through the combination of increased ability of the subordinate rat to defend itself and reduced ability of the dominant rat to attack.

Amphetamine 1 mg/kg, if administered to the victor, sharply reduced its EAP, and in some cases the role of victor was exchanged. When this drug was given to the subordinate rat, a marked increase in its motor activity took place, but as a rule this activity was not aimed at occupying the dry area. No characteristic increase in EAP of the dominant rat was observed in this case or when amphetamine was given to both rats of the pair.

It can accordingly be concluded that after administration of a single dose of neuroleptics, antidepressants, tranquilizers, and the stimulant amphetamine, established domination-subordination relationships may be disturbed on account of a decrease in the ability of the dominant rat to attack effectively and an increase in the ability of the subordinate rat to defend itself. With an increase in the doses of antidepressants given to the subordinate rat, its ability to behave competitively is strengthened.

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