Although benztrpine produced a high degree of complex stereotype behaviour, the extreme forms of stereotypy that are observed with higher doses of amphetamine, however, could not be produced by benztrpine (1, 5). Arnfred and Randrup (4) have also reported a close similarity between the behavioural actions of anticholinergics and amphetamine. The complex stereotypy due to benztrpine has been explained on the dopamine re-uptake inhibiting property of the drug (6, 8–10), as it potentiated that this behaviour is due to 1-dopa. The failure of imipramine to modify the individual or the combined action of benztrpine and 1-dopa suggests that both benztrpine and imipramine have different affinities for norepinephrine and dopamine neurons. Pretreatment with imipramine or benztrpine selectively reversed the effects of 6-hydroxodopamine, which is known to be taken up by both norepinephrine and dopamine neurons, on ambulation and rearing respectively (unpublished data), thus indicating the differences in the affinities of imipramine and benztrpine for norepinephrine and dopamine neurons as simple and complex stereotypies were mediated by brain noradrenergic and dopaminergic systems respectively (2).

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RIGIDITY IN RATS DUE TO ANEMIC DECEREBRATION AND THE EFFECT OF CHLORPROMAZINE

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Rigidity produced by anemic decerebration is thought to be dependent on hyperactivity of α-motoneurons and has been the subject of neuropharmacological study (1, 2) as well as intercollicular decerebrate rigidity (so called 7-rigidity) (1–5) and ischemic spi-
nal rigidity (4, 6–8). Anemic decerebrate rigidity of cats was originally reported by Pollock and Davis (1930), who succeeded in producing the rigidity by means of ligation of the basilar and the common carotid arteries (9). Due to the feasibility of using rats as experimental animals, an attempt was made to produce anemic decerebrate rigidity in these animals.

The principle was similar to that described by Pollock and Davis (9), however certain techniques were modified as follows: 1) Exposure of the basilar artery was performed from the anterior cervical region instead of the palate and 2) cauterization was employed to terminate blood supply to the brain through the basilar artery. Male Wistar rats weighing from 200 to 550 g were anesthetized with ether and fixed on their back. After the oesophagus and bilateral common carotid arteries had been exposed, the trachea was canulated; and the oesophagus was then cut between two placed ligatures. The occipital bone was exposed by scraping off the adhering muscles. After the common carotid arteries had been ligated bilaterally, a trephined opening (diameter 5 mm) was made in the

Fig. 1. (a) : The operative field. (b) : Photograph of a rigid rat (male, 350 g), 45 min after anemic decerebration. (c) : Drawing of the mid-sagittal plane of the brain after i.v. injection of methylene blue. Spotted areas show stained parts of the brain which were not anemic. The arrow indicates the area of cauterization.
central part of the bone so that the basilar artery was made visible. Trephining was carried out carefully to avoid injuring the dura mater. In a state of adequate anesthesia, the dura mater was cut along the basilar artery, and the artery (Fig. 1a) was cauterized using bipolar pincette electrodes of a coagulator (Mizuhoika Micro IC). As soon as the procedure was finished, the administration of anesthesia was discontinued.

Rigidity developed within 30 min after ligation of the common carotid arteries and cauterization of the basilar artery. Marked extension of the forelimbs and rigidity of the neck occurred and continued, followed by extension of the hindlimbs and the tail (Fig. 1b). Rigidity of the forelimbs was particularly remarkable and lasted for more than 2 hr. During this time, the rate of respiration was faster than that of normal rats; and corneal reflexes disappeared although pinna reflexes were still present. Rigidity due to anemic decerebration occurred in 192 out of 357 animals (54%). Failure to produce rigidity was attributed mainly to excessive bleeding during the procedure.

Certain areas of the brain were demonstrated to be anemic by means of an intravenous injection of saturated solution of methylene blue (3 ml/animal) into the femoral vein. Several min after the injection, the animal was sacrificed; and the brain was excised, immersed in 10% formaline for 24 hr and then cut longitudinally. Differentiation between the normal and the anemic areas of the brain was made possible by visually observing histological preparations in which the anemic areas remained unstained. The smaller inferior anterior part of the cerebellum, the medulla, and the spinal cord were stained (Fig. 1c). The difference between the anemic and the intercollicular decerebrate rigidities in rats was that, in the former type, a greater part of the cerebellum and all of the pons were decerebrated. The anemic decerebrate rigidity preparation in rats was somewhat different from that in cats, since in these animals the inferior half of the cerebellum and the caudal half of the pons were stained (9).

In order to study the participation of the γ-loop in the occurrence of the rigidity, the effect of deafferentation on the rigidity was examined. Rats were previously subjected to unilateral deafferentation of the left forelimb. Anesthetized with pentobarbital-Na 35 mg/kg, i.p., the animal was fixed prone, laminectomy was carried out and then dorsal roots C4-C8 were sectioned on the left side. Two or three days after cutting of the dorsal roots, anemic decerebration did not result in rigidity in the deafferented left forelimb. Two or three weeks after the cutting, however, rigidity did occur in both the left and right forelimbs. This may indicate that the function of the γ-loop has no or little influence on the occurrence of anemic decerebrate rigidity in rats.

The electromyographic responses recorded from the muscle of the forelimb were employed as measures of the intensity of the rigidity. Chlorpromazine-HCl (500 μg/kg), injected into the femoral vein, exerted little or no effect on the rigidity (Fig. 2); although in the intercollicular decerebrate rigid rats, considerable depression was seen by a smaller dose of the drug. The mean depression level of anemic decerebrate rigidity was approx. 50% even with a larger dose of 2.0 mg/kg of chlorpromazine-HCl (Fig. 2). Thus, the effect of chlorpromazine was much stronger on intercollicular decerebrate rigidity
Fig. 2. Effect of chlorpromazine on the rigidity of the anemic decerebrate rat. EMG responses were recorded by a coaxial needle electrode inserted into the M. triceps brachii of the rigid rat. The responses were amplified and displayed on an oscilloscope. Discharges were transformed into square waves and fed every 4 sec into an integrator, the output of which was recorded using a DC-recorder (Toa Electronics EPR-2T). Liquid paraffin was utilized to prevent exposed muscles from drying. (a) : Record of the impulse frequency. Vertical bar indicates frequency of 200 Hz. (b) : Log dose-response relationship for chlorpromazine. Abscissa : Dose of the drug, on a logarithmic scale. Each point represents the mean of the frequency of EMG activity in 5 different experiments, with the S.E. indicated.

than on anemic decerebrate rigidity. The fact seems to depend upon the preferential depression of γ-motoneurons by chlorpromazine (1, 2). It cannot be ruled out, however, that the difference in the effect of chlorpromazine in reducing the rigidities of two different types may be attributed in part to the difference in the intensity of the two rigidities, for the anemic decerebrate rigidity was obviously greater than that of intercollicular decerebrate rats.

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