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Short communication

UTILITY OF THE NEUROLOGICAL EXAMINATION IN RATS

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Abstract. This study presents general observations of neurological examination in rats after various CNS manipulations. The examination consisted of neurologic reactions as described in Bureš and co-workers. Subjects studied were controls, hippocampal irradiates, and animals with cerebellar lesions or midline cerebellar transplants. Utility of the procedure as an adjunct to more detailed testing is discussed.

A neurological examination generally provides information on the integrity of various levels and functions of the nervous system. Although the neurological examination in animals is much less sophisticated than in humans, it can sometimes be useful when evaluating the overall performance capacity of an animal. To this end, Bureš, Burešová and Huston (1), have developed a neurological test protocol, similar to a clinical neurological examination, to provide useful information on the nervous system of a rat. Basically, the tests provide information on regular, reproducible, innate reactions. It was thought that, because such an exam could be useful in a behavioral laboratory, the present study would address itself to the pattern of test results that would occur as a consequence of various CNS manipulations. It is recognized that interpretation of results from this test may be at times difficult but nonetheless it was felt that the procedure could offer an overall index of central nervous system functions.

All subjects tested were male Long–Evans hooded rats between three and four months of age. The five groups of rats included controls ($n = 21$), hippocampal irradiates ($n = 14$) (see 3), cerebellar trans-

plant animals ($n = 3$) (2), 10 day postnatally cerebellar lesioned animals ($n = 7$), and 21 day cerebellar lesioned animals ($n = 4$).

TABLE I

Procedure for the administration of the neurological exam on rats (adapted from 1)

Scoring — The general procedure for each of the tests is to present the test stimulus and observe the reaction. The reaction to the stimulus should be immediate. If the animal produces the correct response, a 1 is scored. If no response or an inappropriate response is emitted, a 0 is used. Comments can be made.

Tests

1. Flexion Reflex (tests spinal cord) — the rat is picked up and the toes are pinched with forceps. The response is to move the foot away.
2. Grasping Reflex (tests cerebral cortex) — the rat is picked up and the palm is touched with a wire. The response is to grip the wire.
3. Righting Reflexes (tests pons and mesencephalon) — (a) when the rat is put on its back, it turns over immediately; (b) the animals is held in the lower back; when the body is tilted, its head moves opposite; (c) the rat is on its back when its head is tilted, its limbs move opposite; (d) when the rat is dropped, upside down, from 40 cms., it lands rightside up.
4. Placing Reactions (tests cerebral cortex) — (a) hold the rat near a table; "when the dorsum of the paw contacts the edge of the table, the paw is placed..." on the surface; (b) hold the rat near a table —"when the chin touches the table..." *both* paws are placed on the table; (c) put the rat on the table — when a leg hangs over the edge, it will be placed back on the table; (d) the rat is held by the tail over a table until its whiskers get near — the paws are then put near/on the table; (e) same as (d) but the whiskers do not touch the table — *by sight* the rat tries to touch the table.
5. Equilibrium Tests (tests pons and mesencephalon) — (a) when the rat is placed head downwards on a wire platform at 30° it turns to climb upwards. (b) the rat is placed on a bar and should be able to stay there for about 3 minutes. (c) same as (b) but the bar is slowly rotated (1 rev/10 sec). Rat should stay on.
6. Corneal Reflex (tests medulla, pons and upper cervical cord) — hold the rat, touch the cornea (eye) with a hair — the rat closes the eye.
7. Pupillary Reflex (tests pons and mesencephalon) — look at the eye of a rat with a red light, under a magnifying glass; turn on a white light — the pupil should constrict.
8. Auditory Startle (tests medulla) — when the rat is quiet on a level surface, give a loud hand clap; it should flex forelimbs and extend hindlimbs, arch the body.
9. Toe Spreading (test many levels) — put the rat on a piece of plexiglass over a mirror; when the plexiglass is tilted, the rat spreads his toes.
10. Head Shaking (tests medulla) — when a puff of air is blown through a rubber tube to the ear, the rat shakes his head.

The neurological examination was administered to all the rats, as described by Bureš et al. (1). The ten categories of reactions tested were: the flexion reflex, grasping reflex, righting reflexes, placing reactions, equilibrium tests, corneal reflex, pupillary reflex, auditory startle test, toe spreading, and head shaking tests. The presence or absence of the appropriate reaction was scored. See Table I for the exact procedure used.

Following behavioral testing all animals were sacrificed by transcardial perfusion using 10% buffered formalin. The brains were blocked in the coronal plane and sectioned at 8 μm. Tissue was stained with H and E and matched sections examined to evaluate the extent of damage. The hippocampal x-irradiation resulted in a reduction of approximately 70% in the granule cells of the dentate gyrus. Results of midline cerebellar lesions revealed a loss of approximately 60–80%

TABLE II

Percentages correct on the subtests of the neurological exam after various CNS manipulations

Test	CNS manipulations				
	Control (n = 21)	Hippoc X – Irrad (n = 14)	Cerebellar Transplant (n = 3)	Cerebellar lesions	
				10 day (n = 7)	21 day (n = 4)
1. Flexion reflex	100	100	100	100	100
2. Grasping reflex	100	92	100	85	75
3. Righting reflexes					
a. on back	100	100	100	100	100
b. body tilted	100	100	100	71	75
c. head tilted	100	92	100	85	100
d. dropped	100	100	100	42	100
4. Placing reactions					
a. forelimb	100	100	100	100	100
b. chin	100	100	100	100	100
c. leg hanging	90	100	100	85	75
d. held by tail	100	100	100	100	100
e. vibrissae	100	100	100	100	100
5. Equilibrium tests					
a. wire mesh	100	92	100	100	100
b. horizontal bar	90	92	66	42	50
c. rotated bar	85	85	66	28	25
6. Corneal reflex	100	100	100	100	100
7. Pupillary reflex	100	100	100	100	100
8. Auditory startle	100	100	100	100	100
9. Toe spreading	100	100	100	100	100
10. Head shaking	90	100	100	71	75

of cerebellar tissue. In the case of those animals receiving midline transplants of embryonic cortical tissue, the growing transplants displaced approximately 80% of the host cerebellum but retained the cytoarchitecture of their region of origin. Fiber interconnections were observed between the transplant and the host brain tissue.

As can be seen in Table II, the control group, which serves as a stan-

dard, performed almost all tests with complete accuracy. One test that they had trouble with was the rotated bar — one of the equilibrium tests. On this test, 85% of the controls performed it appropriately. The cerebellar transplant group and the hippocampal irradiate group gave essentially the same pattern of test results as the control group. Both cerebellar lesioned groups (10 day and 21 day), however, showed different test patterns. The 10 day lesioned group showed some difficulty on the righting reflexes as well as marked problems on two of the equilibrium tests (horizontal and rotated bars). The scores dropped here to 42 and 28% correct, respectively. The 21 day lesion group also had difficulty on the equilibrium tests — 50% correct on the horizontal bar, 25% correct on the rotated bar.

Based on the pattern of test results by the control animals, the most difficult neurological test would be the rotated bar, where they performed with only 85% accuracy. Therefore, when using the exam for rats, care should be given to interpret this particular subscore. The hippocampal degranulated rats performed in a similar fashion to controls which was expected. Also, animals with forebrain tissue transplanted into the cerebellum performed similarly to controls. This would seem to rule out at least gross sensorimotor impairments in these groups. The lack of severe deficits in the transplant animals is of particular interest in light of the amount of host cerebellar tissue that has been displaced by the growth of the transplant. On the other hand, the cerebellar lesioned groups showed problems primarily with the equilibrium tests. This was also expected and in this respect points out the usefulness of the neurological protocol. In summary, based upon the patterns of test results obtained with our animals, the neurological exam can be seen as a gross technique for the uncovering of major neurological dysfunctions in rats and in the testing of basic performance capabilities before additional, more specialized testing is attempted. However, more complex cognitive and emotional tests would need to be added in order to give a clearer picture of the animal's total behavioral potential. The utility of the procedure is further indicated by the range of CNS manipulations studied in the present investigation.

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