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VESTIBULAR INDUCED BEHAVIOUR OF RATS BORN AND RAISED UNDER HYPERGRAVITY CONDITIONS

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1. INTRODUCTION

A gravity level change from 1 G to prolonged weightlessness or from prolonged hypergravity (HG) to normal gravity (NG) can cause symptoms of motion sickness.[1,2] Therefore, it is thought that ground-based experiments, in which humans or animals are exposed to sustained HG conditions, can bring about symptoms of the Space Adaptation Syndrome.[1]

It has been shown that vestibular induced behaviour of hamsters born and raised at 2.5 G is less appropriate than that of control animals.[3] In the present study, rats are bred in a centrifuge in order to investigate how the vestibular system is affected by long-term HG conditions. Two types of vestibular induced behaviour are studied, i.e. the airrighting reflex (turning from a supine to prone position during fall) and the reappearance at the water surface after a fall. Both types of behaviour require orientation relative to the direction of gravity. And the question is whether this behaviour at 1 G is affected by the ontogenetic development of the vestibular system under HG conditions.

2. METHODS

One group of Long-Evans rats lived at normal gravity conditions (NG group; 1 G; 4 animals). Another group were conceived and born, and thereafter lived, at increased gravity in a centrifuge (HG group; 2.5 G; 14 animals). The centrifuge comprises two horizontal arms (length: 1.15 m) with aerated free-swinging gondolas (length: 1.10 m, width: 0.45 m, height: 0.725 m). The centrifuge constantly rotates at 34.3 cycles/minute resulting in a hypergravity level at the bottom of the gondola of |Z| = 2.5 G, with the Z-vector always perpendicular to the bottom.

Experiments started 5-7 days after weaning (at the age of 4 weeks) and were performed at 1 G for all animals. Every experimental session, animals were dropped three times from a supine position (height 0.65 m) into a water basin. This test was performed every two (eventually four) weeks under infrared illumination to eliminate visual input. To avoid further distress for animals that remain under water, the light was switched on 3 seconds after the animal hit the water surface, and the animal was rescued. Their behaviour was recorded on VCR.

Afterwards, the number of correct airrightings and their duration (time interval between release and attaining a prone position) were determined. Also, the time intervals between hitting the water surface and the subsequent resurfacing were measured.

3. RESULTS

The percentages of correct airrighting reflexes and their duration (mean ± SD), for rats bred under normal gravity and under HG conditions, are shown in Fig 1. Because the experiment is still in progress, we can only present the results until week 10 of the NG group.

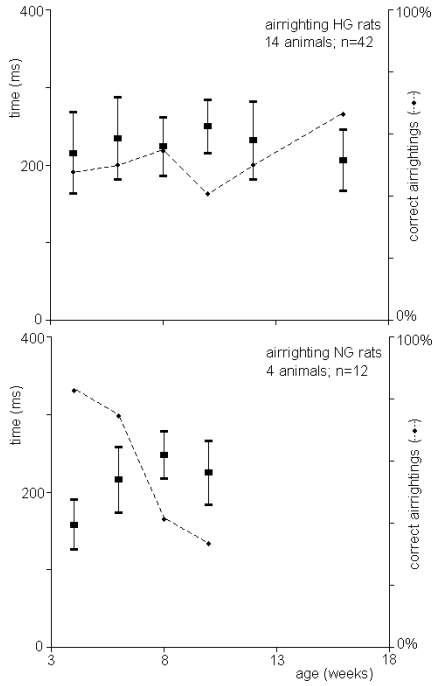

Fig 1: Correct airrightings (dashed line; right-hand vertical axis) and duration of the reflex (mean ± SD, left-hand vertical axis) for rats born and raised under 1 G (n=12) and 2.5 G (n=42) conditions.

The score for the HG group is approximately 50% correct airrightings and doesn't change very much with age. Although more data are required, the airrighting of the NG group appears to be very successful in the first experimental session (week 4) and to decrease when the rats grow older.

The time interval (mean ± SD) between hitting the water and reappearing at the surface (nose up) is shown in Fig 2. At the age of 6 weeks, only a minority of the surfacings of HG rats (36%) occurred within three seconds after hitting the water. The success rate for surfacing within three econdss for HG animals of 8 weeks and older was 100%. Surfacings of the NG group were always performed within three seconds. Young NG animals tend to complete their surfacing faster than HG rats of the same age.

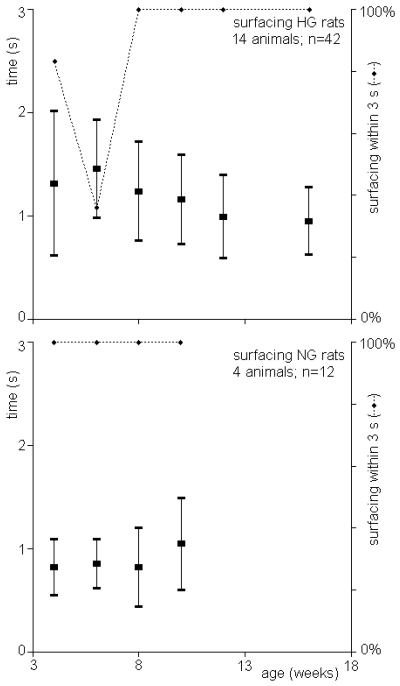

Fig 2: Percentage of surfacings performed within 3 s (dashed line; right-hand vertical axis) and duration of those surfacings (mean ± SD, left-hand vertical axis) for rats born and raised under 1 G (n=12) and 2.5 G (n=42) conditions. The success rate for surfacing within 3 s for HG animals of 8 weeks and older, and for NG animals of all ages tested so far was 100%. The scores for 4 and 6 weeks old HG rats were less (36% at age 6 weeks).

4. DISCUSSION

With respect to the duration of the airrighting reflex, the results do not show remarkable differences between HG and NG rats. In order to evaluate the significance of the decrease of correct airrightings with age, more data will be collected. Nevertheless, our results appear to contrast with those obtained for hamsters, for which it was shown that airrighting is less successful for HG-bred animals.[3]

With respect to surfacing, HG animals appear to experience some trouble only in the first few weeks after weaning. Video recordings show animals floating at the water surface, but with their heads submerged. From the age of 8 weeks onward, HG rats always find their way to the surface. The data of three more HG rats (data not shown) are consistent with the results shown here. NG rats appear to have no problem in finding the water surface at any age. (Although this time series is rather short and the number of animals is just four, we expect that NG animals older than 10 weeks will perform equally well.) For this type of vestibular induced behaviour, there also appears to be a difference with hamsters bred in a centrifuge. It was reported that they have considerable problems with swimming.[3] There appears to be no acute distress among centrifuge-bred rats when the centrifuge is stopped, because all animals become very active immediately (running, fighting, standing on hindlegs). The preliminary results of the study presented here show that vestibular induced behaviour of HG rats is not permanently deteriorated.

5. REFERENCES

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