# Morphometric Peculiarities of the Brain in Two-Month-Old Rats as a Function of Body Weight at the Age of One Month

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Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 124, No. 7, pp. 115-117, July, 1997
Original article submitted March 6, 1996

The brain from 2-month-old rats up to the age of 1 month was studied in litters of different size: 9-13 (control) and 4-6 (reduced) animals. In animals from reduced litters the absolute weight of the brain surpassed that of controls. The maximum brain weight is characteristic of animals from reduced litters with maximum body weight at the age of one month, while the minimal brain mass is found in controls with the minimal body weight. There are no differences in the cortical thickness and neuron density in layers II and V between these two groups.

**Key Words:** *brain; cortex; age; body weight*

A positive correlation has been established between the body weight and the absolute weight of the brain in perinatal ontogeny [1,5]. It has been also demonstrated that delayed development of the brain in the embryonal and early postnatal periods cannot be completely compensated [2,3]. On the other hand, body weight in animals from large litters surpasses that of animals from small litters [4], while the large brain weight in early postnatal period determined by a number of factors and accompanied by increased cortical thickness is characteristic of animals with high body weight [6,7]. At the same time, the question whether the increased brain weight in animals with high body weight during early postnatal ontogeny remains at the later stages or, according to the principle of equifinality [4], this parameter approaches the mean value for the given species remains without answer. Exploration of this problem was the objective of the present study.

## MATERIALS AND METHODS

In order to grow rats with high postnatal body weight, 4-6 rat pups were retained in 6 litters obtained after mating 3-3.5-month-old males and females, while 5 control litters consisted of 9-13 pups. Rat dams rearing their normal and reduced progeny were simultaneously maintained in the same vivarium and fed water and chow (cereals, vegetables, fish, fish flour, milk, and bread) *ad libitum*. The 1-month-old rats were weighed, separated from dams, and kept 5-7 animals per cage (males separately from females) with water and the same chow *ad libitum*. At the age of 2 months the animals were decapitated, and body and brain weights were determined. The anteroparietal fragment was obtained from the left hemisphere, fixed in Carnoy fluid, and embedded in paraffin [5-7]. The data were processed statistically, the correlations between the absolute brain weight and body weight in 1- and 2-month-old rats ($r_1$ and $r_2$) were analyzed.

## RESULTS

Body weight in 1-month-old rats from reduced litters considerably surpassed that of control animals (by 44.7% in males and 61.9% in females, Table 1). This parameter greatly varied in both groups (Table 1). In 2-month-old females this difference markedly de-

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0007-4888/97/0007-0722$18.00

**TABLE 1.** Effect of Litter Size and Body Weight at the Age of 1 Month on the Brain of 2-Month-Old Rats

| Parameter | | Control litters | | Reduced litters | |
|---|---|---|---|---|---|
| | | males | females | males | females |
| Body weight, g | 1 month | 48±2.5 (27-72) | 42±2.5 (23-67) | 68±4.4* (46-83) | 68±3.1* (42-85) |
| | 2 months | 140±4.2 (110-168) | 129±6.1 (101-170) | 182±11.3* (120-242) | 139±3.9 (118-165) |
| | in big rats | | | 211±10.6* | 176±6.7* |
| | in small rats | 133±5.6 | 118±8.6 | | |
| Absolute brain weight, mg | | 1618±19 (1480-1740) | 1541±20 (1440-1700) | 1671±29.6 (1560-1900) | 1602±17.3* (1520-1700) |
| | in big rats | | | 1776±25.9* | 1623±31.9* |
| | in small rats | 1556±30 | 1464±8.6* | | |
| Relative brain weight, mg/g | | 11.6±0.2 | 12.1±0.41 | 9.6±0.63* | 11.6±0.25 |
| | in big rats | | | 8.3±0.45* | 10.95±0.39* |
| | in small rats | 11.8±0.39 | 13.2±0.38 | | |
| Correlation coefficients: | | | | | |
| | $r_1$ | 0.821 | 0.81 | 0.75 | 0.657 |
| | $r_2$ | 0.416 | 0.658 | 0.415 | 0.643 |
| Cortical thickness, μ | | 1584±40 | 1548±22 | 1537±55 | 1570±32 |
| | in big rats | | | 1537±74 | 1546±62 |
| | in small rats | 1644±129 | 1572±62 | | |
| Number of neurons in vision field | | | | | |
| | layer II | 18.1±1.78 | 17.8±1.8 | 20.3±1.12 | 18.6±1.2 |
| | layer V | 11.4±1.4 | 8.8±0.49 | 10.9±0.34 | 8.4±1.3 |
| in big rats | layer II | | | 21±2.0 | 18.5±1.5 |
| | layer V | | | 10.5±1.1 | 11.4±1.6 |
| in small rats | layer II | 19.8±1.4 | 19.4±3.9 | | |
| | layer V | 9.6±1.9 | 10.2±1.9 | | |

**Note.** *$p<0.05$ compared with the mean values in the control group; extreme values are shown in parentheses.

creased and became statistically insignificant, while in 2-month-old males it was preserved. The absolute brain weight in animals from reduced litters surpassed that in controls, this difference being insignificant in males. In further analysis we isolated the following subgroups in both groups: small animals (control rats weighing less that 35 g at the age of 1 months) and big animals (rats from reduced litters weighing more that 70 g at the age of 1 month). At the age of 2 months the small and big animals had the minimum and maximum body weight, respectively (Table 1). A positive correlation was noted between the absolute brain and body weight measured at the ages of 1 and 2 months. The relative brain weight was inversely proportional to body weight and was maximal in small and minimal in big rats. This interrelationship reflects a relative independence of the brain growth, which manifests itself in the fact that extreme groups little differed in the brain weight, while the body weight in big animals surpassed that of small animals 1.5-fold (Table 1).

The thickness of the brain cortex and neuron density in layers II and V were practically the same in both groups as well as in subgroups of big and small rats (Table 1).

The observed differences in the brain weight between animals from control and reduced litters and especially between big and small animals can be attributed to the differences in their body weight at the age of 1 or 2 months. However, in both cases these differences are determined by unequal growth conditions up to 1 month. This also follows from significant difference in the brain weight between females from different groups, while the difference in the body weight was insignificant. On the other hand, the absence of intergroup differences in the cortical thickness and neuron density suggests that in comparison with the brain weight these parameters less depend on the body weight in animals of this age maintained under normal conditions. It can be also assumed that at the same cortical thickness and neuron density, the higher brain weight is associated with the higher total number of neurons.

## REFERENCES

1. G. G. Avtandilov, *Medical Morphometry* [in Russian], Moscow (1990).
2. N. I. Dmitrieva, *Arkh. Anat.*, **74**, No. 1, 106-111 (1978).
3. N. I. Dmitrieva and V. G. Kassil', *Ibid.*, **83**, No. 9, 84-89 (1982).
4. M. V. Mina and G. A. Klevezal', *Animal's Growth* [in Russian], Moscow (1976).
5. B. Ya. Ryzhavskii and S. I. Biryukova, *Byull. Eksp. Biol. Med.*, **116**, No. 12, 641-642 (1993).
6. B. Ya. Ryzhavskii and S. I. Biryukova, *Fiziol. Zh.*, **80**, No. 1, 119-122 (1995).
7. B. Ya. Ryzhavskii and I. R. Eremenko, *Ibid.*, **78**, No. 5, 109-112 (1992).