ADRENOCORTICAL FUNCTION DURING PASSIVE AVOIDANCE LEARNING IN PREPUBERTAL RATS

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UDC 612.833.81+612.825.1]-08:
612.1753.018

KEY WORDS: corticosterone, adaptation, passive avoidance learning, ontogeny.

A previous publication [2] gave data on the dynamics of changes in the plasma 11-hydroxycorticosteroid (11-HCS) level during formation and extinction of passive avoidance learning (PAL) in pubertal rats adapted beforehand to the experimental conditions. The aim of this investigation was to study adrenocortical function in similar experiments but on prepubertal animals.

EXPERIMENTAL METHOD

Experiments were carried out on 193 male Wistar rats from the Institute's nursery. Experiments began on the 25th-28th day after separation of the young rat from its mother. Toward the end of the experimental period the animals were 35-40 days old. For 7 days the rats were placed for 3 min daily in a large, lit chamber, from which because of inborn preference for dark and confined spaces, they moved into a small, dark chamber of the apparatus. On the 8th day after the rat had been in the small chamber for 3 min, electric shocks (ES) were applied through the grid floor of the chamber. The presence of PAL – no switching from the large to the small chamber during 3 min – was tested after 1-5 days. Adapted rats not receiving ES served as the control. The 11-HCS concentration was determined fluorometrically [4] in plasma obtained after decapitation of the rats in the animal house (basal level) or in the experimental room. The results were subjected to statistical analysis by Student's test.

EXPERIMENTAL RESULTS

As Table 1 shows, young animals placed for the first time in the experimental chamber, like the pubertal animals [2], responded to the new situation by a considerable rise in the corticosterone level ($P < 0.001$) followed by a further rise after ES ($P = 0.02$). It may be recalled that the basal 11-HCS level in the unadapted animals of both age groups was virtually identical, in agreement with data published elsewhere [5, 6, 8].

After 7 days of adaptation of the rats to the experimental situation the basal 11-HCS level was raised ($P < 0.02$) and placing the animal in the chamber did not lead to any significant hormonal shift. This type of response also was maintained 5 days after the end of the adaptation period. Comparison of these results with those of the previous investigation [2] reveals a significant difference in the response of the adrenal cortex to adaptation to the new situation in animals of different ages. In rats aged 2 months, unlike those aged 1 month, after 7 days of adaptation a fall was observed in the basal 11-HCS level, and as before, there was a marked rise after the animals had stayed 3 min in the experimental chamber.

Meanwhile, just as in adult rats, in adapted prepubertal rats there was a more marked hormonal response to ES compared with the response to the small chamber than in unadapted animals.

The presence of PAL 24 h after ES was found in 60% of prepubertal rats, compared with 88% after 5 days (55 and 71% respectively in rats aged 2 months). In 30% of rats not exhibiting PAL 1 day after ES, it was found on the 5th day (at the age of 2 months there were 19% of such animals).

Differences in the 11-HCS concentration were found 24 h after ES in young rats, just as in adult rats, between animals exhibiting and not exhibiting PAL. In rats with a reflex present the plasma corticosterone level was considerably lower than in animals without PAL ($P < 0.05$). These differences, just as in adult rats, disappeared 5 days after electrical stimulation.

Laboratory of Ontogeny of Higher Nervous Activity, I. P. Pavlov Institute of Physiology, Academy of Sciences of the USSR, Leningrad. (Presented by Academician of the Academy of Medical Sciences of the USSR N. P. Bekhtereva.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 97, No. 6, pp. 645-647, June, 1984. Original article submitted May 12, 1983.

0007-4888/84/9706-0704 $08.50

TABLE 1. Plasma 11-HCS Concentration (in μg%) in Month-Old Rats at Different Times after Adaptation to Experimental Situation and PAL (M ± m)

Experimental conditions	Unadapted animals	Adapted (for 7 days) animals				
		after period of adaptation		after ES		
		1 day	5 days	1 day	5 days	
					1 day after absence of PAL	1 day after presence of PAL
Control (basal level)	25,6±4,14 (12)	39,0±3,76 (10)	34,1±4,60 (8)	29,6±3,60 (10)	29,9±4,15 (10)	32,5±5,30 (8)
After a stay of 3 min in experimental chamber: small	51,0±3,92 (12)	47,7±6,45 (10)	48,8±5,65 (8)	55,5±4,56* (13)	32,9±2,63* (16)	39,7±5,75* (6)
large (presence of PAL)	—	—	—	43,5±3,20 (15)	35,1±6,29 (7)	31,5±1,78 (28)
16 min after ES	68,9±5,81 (10)	99,5±7,61 (10)	—	—	—	—

Legend. Asterisk indicates absence of PAL; number of animals shown in parentheses.

However, one fact to be noted is that, unlike in pubertal animals, the 11-HCS level in prepubertal rats with PAL was still higher than the basal level ($P < 0.01$) and it fell to that level only in animals in whom the reflex was still present on the 5th day after ES (in rats aged 2 months these differences had disappeared as early as on the first day). This pattern, evidently reflecting a high level of emotional reactivity, like the elevation of the basal 11-HCS level observed as a result of adaptation of the prepubertal rats to the experimental situation, evidently depends on generalization of perception characteristic of early postnatal ontogeny [3], and also on incomplete development of the hippocampus [1, 7].

Meanwhile similarity of the behavior of the animals of the two age groups during PAL as regards their hormonal response depending on the presence or absence of the reflex, is evidence that the principal mechanisms of regulation of defensive behavior and its autonomic correlates are already formed in rats at the age of 5-6 weeks.

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