

ROLE OF STRIOPALLIDARY NUCLEI IN THE DEVELOPMENT OF SKIN-CLEANING REFLEXES DURING INDIVIDUAL DEVELOPMENT OF RABBITS

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The caudate nucleus or globus pallidus was destroyed bilaterally in rabbits aged 9-11 days and the development of spontaneous skin-cleaning reflexes (washing, scratching, licking, and shaking) was studied. After destruction of the globus pallidus there was a marked increase in the number of shaking movements in the third week of life; destruction of the caudate nucleus led to an increase in the number of all cleaning reflexes at the end of the first month. It is postulated that normal functioning in the intact organism is associated with an inhibitory effect of the caudate nucleus on the cleaning reflexes, thereby participating in the control over cleaning activity; the influence of the globus pallidus, however, is restricted to very weak and brief inhibition of the shaking reflex.

Skin-cleaning reflexes - washing, scratching, licking, and shaking - belong to the group of inborn reflexes in rabbits which, appearing in the intrauterine period, continue to develop after the animal's birth [3]. The results of observations on the development of these "maturing" reflexes after artificial blocking of particular brain structures could shed light on the role of these structures in the reflexes concerned and in the mechanisms of their evolution.

The writer has previously [8] investigated the influence of the cerebral cortex on the evolution of the cleaning reflexes in rabbits at various age periods.

In the present investigation the role of the caudate nucleus and globus pallidus in the development of skin-cleaning reflexes was studied in young rabbits; only spontaneous reflexes and not those evoked by stimulation of the skin were investigated.

EXPERIMENTAL METHOD

All the spontaneous skin-cleaning reflexes of the rabbits used in the investigation were recorded in detail for 10 min daily after the age of 4-5 days. The control group (1) included 15 animals. At the age of 9-11 days unilateral or bilateral electrical coagulation of the globus pallidus was carried out on 10 rabbits of group 2 and bilateral coagulation of the head of the caudate nucleus was performed on 10 rabbits of group 3. The experiments were resumed 1-2 days after the operation and continued until the end of the sixth week of life. The results of a subsequent morphological investigation demonstrated that electrical coagulation had fully achieved its purpose in all the rabbits undergoing the operations.

EXPERIMENTAL RESULTS

Spontaneous skin-cleaning reflexes were observed from the age of 6-7 days, after which their number increased with each successive day to reach a maximum in the third week. The end of the second and the third weeks were the period of "exaltation" of cleaning activity, after which it gradually reduced to be maintained at a relatively constant and low level by the end of the first or beginning of the second month of life.

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TABLE 1. Distribution of Types of Cleaning Reflexes in Experimental and Control Rabbits

Age of animals (in weeks)	Washing			Scratching			Licking			Shaking			Total number of reflexes		
	group of animals														
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
1	0,0	0,0	0,0	0,8	0,6	0,4	0,7	2,3	0,4	0,0	0,0	0,0	1,5	2,9	0,8
2	0,4	0,4	0,6	10,4	10,6	10,3	7,1	8,3	8,2	2,7	3,3	2,5	20,6	22,6	21,6
3	1,0	0,8	1,0	9,6	8,0	11,8	12,7	11,3	13,6	3,7	7,0	6,0	27,0	27,1	32,4
4	0,6	0,9	0,8	2,8	3,6	4,6	8,1	8,2	11,5	1,4	2,6	3,1	12,9	15,3	20,0
5	0,6	0,5	0,7	1,2	3,1	2,9	4,9	7,1	8,1	0,3	0,7	0,4	7,0	11,4	12,1
6	0,4	—	0,4	0,9	—	1,4	4,5	—	5,6	0,4	—	0,3	6,2	—	7,7

Note. Number of cleaning reflexes during the experiment (mean per rabbit) is given for each week.

The operations were performed at an age immediately before the period of "exaltation."

The experiments showed that destruction of the caudate nucleus or globus pallidus produced no appreciable changes in the animals' behavior. These nuclei were found to play a different role in the development of the skin-cleaning reflexes. In the animals of group 2 the changes in these reflexes were very slight (Table 1). After both unilateral and bilateral destruction, an increase only in the number of the shaking reflexes was observed in the third week of life ($P < 0.05$) with a small increase in the total number of cleaning reflexes in the animals undergoing the operation compared with the controls on the fourth and fifth weeks, affecting all the skin-cleaning reflexes to about the same degree, but the increase was not statistically significant. Most workers who have studied the functions of the globus pallidus have drawn attention to the role of this structure in conditioned-reflex activity [4, 15, 17], to changes in the unit activity of the globus pallidus during the performance of certain movements [14, 18], or to the role of the globus pallidus in changes in the bioelectrical activity of other brain structures [5], and have not considered its influence on inborn reflexes such as those concerned with cleaning the skin. Since in the present experiments the most significant result of destruction of the globus pallidus was an increase in the number of shaking movements, the influence of the globus pallidus under normal conditions can be assumed to be nothing more than slight inhibition of the shaking reflex.

Destruction of the caudate nucleus (the animals of group 3) led to more marked changes. In the caudectomized animals the strength of the scratching, licking, and shaking reflexes was increased slightly (the washing reflex appeared so rarely in both the caudectomized and control animals that it can be taken to be virtually absent). Admittedly, the increase in the number of reflexes of each type was small (Table 1) but the total increase was significant, especially in the period of reduced cleaning activity: in the fourth week of life the total number of skin-cleaning reflexes in the control rabbits averaged 12.9 ± 1.1 per experiment compared with 20.0 ± 2.1 in the animals undergoing the operation, i.e., an increase of 7.1 ± 2.3 ($P < 0.01$), while in the fifth week the numbers were 7.0 ± 0.9 and 12.1 ± 1.6 respectively, i.e., an increase of 5.1 ± 1.8 reflexes in the caudectomized animals ($P < 0.01$). Destruction of the caudate nucleus thus facilitates cleaning activity to a small degree. Similar results were obtained in experiments on rats [19]. This suggests that during normal function in the intact animal the caudate nucleus slightly inhibits skin-cleaning reflexes, in agreement with the views held by most investigators [1, 6, 9, 16, 20] on the caudate nucleus as a structure with a predominantly inhibitory function.

The writer showed earlier [8] that the cerebral cortex inhibits skin-cleaning reflexes, especially after the fourth week of life. The results of the present investigation showed that the caudate nucleus has a similar action on the cleaning reflexes at the same times. This suggests that both cortex and caudate nucleus participate in the inhibition of excessive cleaning activity. The caudate nucleus perhaps acts directly on the subjacent structures; however, since connections exist between the cortex and caudate nucleus, as has been demonstrated morphologically and functionally [2, 7, 10, 12], the possibility cannot be ruled out that the caudate nucleus participates indirectly in the inhibition of cleaning reflexes through increasing the excitability of the cortex.

In rabbits differentiation of the nuclei of the striopallidary system is not yet complete at birth [11]. Nevertheless, in the early postnatal period they are more mature than the cerebral cortex. In monkeys the caudate nuclei begin to function earlier in ontogeny than the cortex, and at an early age they may perform functions which are later taken over by the cortex [13]. In the present experiments no such anticipation occurred: the caudate nucleus, despite its greater maturity than the cortex, did not take part in the regulation of cleaning activity before the cortex. This suggests that the role of the caudate nucleus in cleaning activity is subsidiary to that of the cortex.

The results of the present investigation thus show that destruction of the caudate nucleus at an early age changes the course of subsequent development of skin-cleaning reflexes to a slight extent and causes an increase in the total number of cleaning reflexes later in life, thereby prolonging the period of "exaltation" of cleaning activity. Destruction of the globus pallidus, however, is followed by only slight and brief changes in the development of the cleaning reflexes.

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