The total amount of noradrenaline in the heart, as well as the concentration in the heart, shows a probably significant increase in the trained guinea-pigs. In the other measured parameters, no overt differences are seen.

Effect of chronic physical training on the catecholamine content of the heart and the adrenal glands of the guinea-pig

	Controls (n = 14)	Trained animals (n = 13)
Initial body weight ± S.E.M. (g)	271 ± 5	274 ± 4
Final body weight ± S.E.M. (g)	846 ± 18	808 ± 16
Heart weight ± S.E.M. (g)	2.29 ± 0.07	2.39 ± 0.04
Heart ratio ± S.E.M. (g/100 g body weight)	0.27 ± 0.005	0.30 ± 0.003[a]
Adrenal weight ± S.E.M. (paired organs) (g)	0.46 ± 0.02	0.44 ± 0.03
Total noradrenaline in heart ± S.E.M. (µg)	3.42 ± 0.32	4.26 ± 0.17[b]
Noradrenaline concentration in heart ± S.E.M. (µg/g)	1.48 ± 0.12	1.78 ± 0.06[b]
Total adrenaline in adrenals ± S.E.M. (µg)	82 ± 5	88 ± 5
Adrenaline µg/kg body weight ± S.E.M.	100 ± 7	110 ± 7

[a] Different from controls $P < 0.001$. [b] Different from controls $P < 0.05$. n, number of animals.

Discussion and conclusions. From the present study it is evident that a prolonged physical training, giving rise to a cardiac hypertrophy as indicated by the increase in heart ratio, does not lower the cardiac noradrenaline content. On the contrary, a slight increase is seen. In the studies in which a decrease in amount of sympathetic transmitter of the heart was noticed[1,2], no cardiac hypertrophy was observed. This would indicate that a low degree of physical training, not inducing cardiac hypertrophy, has the opposite effect on the amount of sympathetic transmitter in the heart to a physical training giving rise to cardiac enlargement. The reason of this discrepancy, as well as its functional significance, is obscure and requires further investigation.

Zusammenfassung. Ein langdauerndes Training bewirkt keine Herabsetzung der Catecholamine in Herz und Nebennieren des Meerschweinchens.

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[7] This work has been supported by a grant from Svenska Nationalföreningen mot Hjärt- och Lungsjukdomar.

Topographical Investigation of Cortical Afferents to the Red Nucleus in the Cat

Anatomical and physiological studies have shown that the large cells of the red nucleus (RN) receive a topographically organized projection from the motor cortex[1-4]. In this electrophysiological study we have attempted to examine in more detail the characteristics of the corticorubral relation at the unitary level.

Techniques. Results were obtained from 41 cats anesthetized with Chloralose and paralyzed with gallamine triethodide (Flaxedil). Recordings from mesencephalic neurons were made with tungsten microelectrodes that had an impedance equal to or greater than 7 mΩ at 1.000 Hz. The rubrospinal tract was stimulated at a frequency of 0.15 Hz at both the cervical (C2) and thoracic (D9) levels to permit antidromic identification of RN cells. A discrete coagulation was made at the end of each microelectrode descent in order to localize the tip in histological sections.

The effect of stimulation of the pericruciate cortex was tested on cells yielding antidromic responses to stimulation of the rubrospinal tract. Cortical stimulation was achieved by means of 7 pairs of nickle needle electrodes that were varnished except at the tip. Each electrode was lowered through a small burr hole in the skull to a cortical depth of 1.5 mm before being cemented into place. Cortical stimulation, consisting of 3 shocks, was delivered at a constant current of 300 µA to each of the electrode pairs, with each member of the pair serving alternatively as the cathode. In this study, only spikes evoked by stimulation intensities of 150 µA or less and with latencies of 20 msec or less have been included. From a total of 173 antidromically activated cells only 72 achieved these criteria.

Results. The cortical areas explored by the stimulation were the anterior sigmoid gyrus, the anterior portion of the posterior sigmoid gyrus and the gyrus proreus (Figure 1, left). The cortical regions from which it was possible to induce spikes in red nucleus units are shown in Figure 1 right. The points are found in the pre- and post-cruciate cortex of area 4 (according to HASSLER and MÜHS-CLEMENT's division of cortical areas[5]). Stimulation of area 6 failed to evoke spikes in the red nucleus, which is in agreement with SCHMIEDT's evoked potential study of corticorubral projections[6]. The zones of greatest corticorubral projections are, according to WOOLSEY's motor homunculus for the cat[7], the somatomotor areas for the forelimb (i.e. the lateral portion of the anterior and posterior sigmoid gyri) and the hindlimb (i.e. the medial portion of the posterior sigmoid gyrus).

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The projections from the somatomotor cortex to each RN cell are well organized but show a certain degree of convergence as well. Figure 2 gives examples of 4 antidromically identified RN cells. The 2 cells with axon terminations in the cervical cord are found in the dorsal portion of the nucleus. The 2 other cells which send their efferent fibers to thoracicolumbar segments, are located in the ventral RN which corresponds with the known organization of the nucleus. It appears that each rubrospinal neuron receives afferent projections from a relatively wide cortical area sometimes from distinctly different zones in spite of the fact that the projections of greatest density are relatively topological.

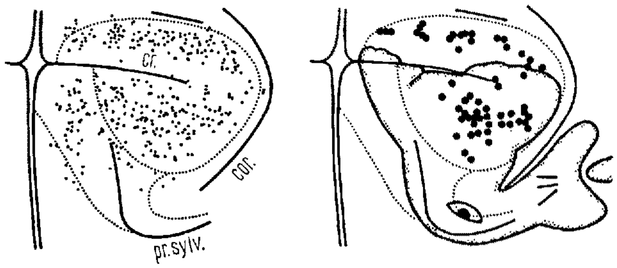

Fig. 1. Sites of cortical projections to RN neurons. A schematic reproduction of the somatomotor cortex. cr, cruciate sulcus; cor, coronal sulcus; pr sylv, presylvian sulcus. The dotted line delimits area 6 (medial pre-cruciate) from area 4 (about the cruciate cortex). On the left is a summary illustration of the regions explored. Each point represents the position of a stimulating electrode. On the right, indicated on WOOLSEY's[7] motor homunculus for the cat, are indicated the sites from which it was possible to induce spikes in red nucleus neurons. These sites are restricted to areas projecting to the limb musculature.

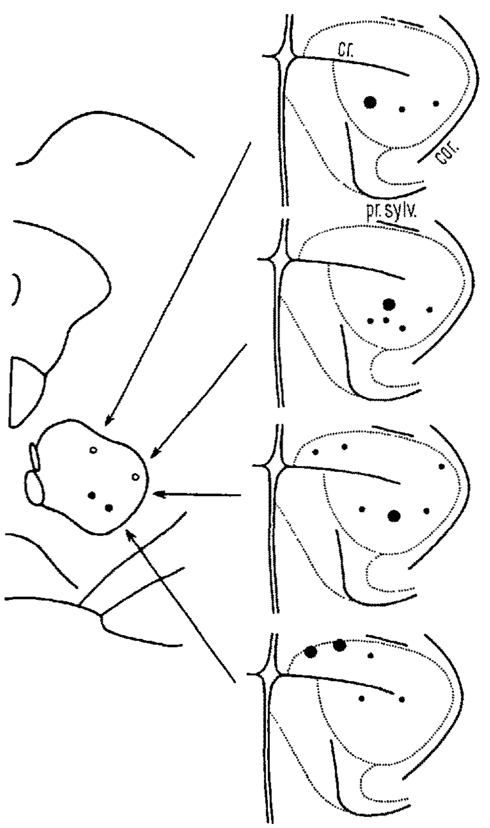

Fig. 2. Cortical projections to 4 RN cells. In the schematic drawing of the RN, the open circles indicate cervical cells and the filled circles lumbar cells. The size of the filled circles on the cortical sketch indicates the efficiency of the projection (i.e. the stimulation threshold required for each point to evoke a spike discharge in a RN unit). The largest circles indicate the lowest thresholds $\leq 50\,\mu A$, the smaller circles indicate thresholds between 50 and 150 μA.

Mapping of the projections to the RN from each part of the somatomotor cortex revealed that the medial post-cruciate cortex (i.e. the hindlimb area) is principally connected to lumbar neurons located in the hindlimb area of the RN. The lateral pre- and post-cruciate zones (the forelimb area) project to the entire nucleus and to neurons controlling the motor function of the hindlimb as well as the forelimb.

There exist at least 3 different faciltatory connections between the somatomotor cortex and the red nucleus; the corticorubral pathway, the collaterals from tonic pyramidal fibers[8] and the cortico-ponto-interposito-rubral pathway[9]. A distinction between the first two and the third multisynaptic pathway was attempted by treating responses with latencies inferior to 7.5 msec as separate from those with longer latencies. No difference between the characteristics of these 2 populations was found and a further attempt to distinguish between the first two systems on the basis of latency was not possible. The conduction velocity for these 2 pathways is of the same order (14 m/s average for tonic pyramidal fibers and 20 m/s for corticorubral fibers[4]). In certain experiments we have stimulated the corticospinal tract antidromically and caused collision in pyramidal fibers, but interpretation remains difficult because the latency of spikes appearing in the red nucleus following cortical stimulation was highly variable. The inefficiency of the corticorubral synapse generally necessitated temporal summation by 3 cortical shocks to propagate activity in RN neurons.

In any case, whatever pathways were activated, the absence of projections from area 6 and the convergence of widespread cortical areas on a single RN neuron appear to be the salient characteristics of the corticorubral relation. This organization of corticorubral projections implies a concept of muscular synergism for muscles of a given limb as well as for coordination of different limbs[10].

Résumé. Il a été montré, par enregistrement unitaire, que les afférences à partir du cortex moteur sur les cellules rubrospinales proviennent seulement de l'aire 4. Ces projections sont organisées de manière topique, bien que certaines cellules soient activées par des zones corticales étendues.

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