

at an early stage in the changing work level, the regulation of amino acid incorporation in the heart is not related to the synthesis of mRNA or rRNA, since the dose and the mode of administration of actinomycin D used in this study is more than effective in preventing the synthesis of RNA¹⁶.

Upon the addition of puromycin and of cycloheximide, the control of synthesis was inhibited (Table). It is therefore postulated that the site regulating amino acid incorporation is at the level of the membrane-ribosome complex. This contention is further supported by the fact that there was a very brief time lag for a detectable difference in the rate of incorporation. Reports from various laboratories show that the life time both of mRNA and of rRNA and the response time for nuclear RNA polymerase are all in excess of 3 h^{3-5,17,18}. In contrast, there has been evidence indicating an extremely rapid control of protein synthesis at the level of translation of preformed template RNA in response to hormones, feeding, partial hepatectomy or stimulation of a skeletal muscle^{6-8,10,18-20}. However, whether or not the control observed in this study is a result of a specific protein¹⁰,

an inhibitor⁷ or some other means of regulation, requires further experimentation²¹.

Zusammenfassung. Die Einbaugeschwindigkeit der Aminosäure steigt mit erhöhter Herzbelastung an. Bei Vorbehandlung mit Actinomycin D bleibt dieses Verhältnis unbeeinflusst, Puromycin oder Cycloheximid indessen hemmen die Proteinsynthese.

K. KAKO and R. MINELLI

*Department of Physiology, University of Ottawa,
Ottawa (Canada), 23 August 1968.*

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²¹ Supported by grants from the MRC, OHF and Bickell Foundation.

Response of Respiration to Selective Heating of the Spinal Cord Below Partial Transection

Afferent conduction of warmth stimuli applied to the spinal cord has been proved by the finding that thermal panting is evoked in conscious dogs by selectively heating the spinal cord¹. Partial cordotomy involving ventrolateral or dorsal funiculi has been performed in the present investigation in order to find out the afferent pathway by which spinal thermal stimuli are conducted to the supraspinal thermoregulatory effectors.

Method. In 20 out of 26 nembutalized rabbits, partial cordotomy of both dorsal funiculi was performed between the fourth and eleventh thoracic segment; in the remaining cases the ventrolateral funiculi were cut on either side. - Heating of the spinal cord below the transection level was performed by means of a thermode which had been implanted into the peridural space between the level of transection and the seventh lumbar vertebra. The thermode was perfused with hot (46-52°C) water for 2-10 min at constant ambient temperatures between 24-28°C. - Electromyograms were recorded from the lower lumbar dorsal trunk muscles using a pair of needle electrodes. Respiratory movements were recorded by displaying on a recorder the changes of electric resistance in an electrolyte-filled, distensible rubber tube, which had been tied round the rabbit's chest. The temperatures within the rectum and the peridural space of the lumbar vertebral canal and the skin temperature of one ear were measured by thermocouples. Several days after the cordotomy, the animals were sacrificed. The spinal cord was fixed with Müller's solution, and Marchi's stain was performed.

Results. In Figure 1, the response of respiration and muscular activity to spinal cord heating below the level of bilateral transection of both dorsal funiculi is demonstrated. Partial cordotomy had been performed at the sixth thoracic segment as indicated by the hatched part of the inset Figure. At an ambient air temperature of 24°C and a rectal temperature of 38.2°C, slight cold shivering was observed in this lightly anaesthetized animal before the spinal cord was heated (left side of the Figure).

After 4 min of spinal cord heating (middle part), vertebral canal temperature had risen to 41.8°C. Shivering had disappeared, and respiratory rate had increased to a tachypnoic level. Further, cutaneous vasodilatation is indicated by the rise of ear skin temperature at constant ambient and rectal temperatures. This combined response to heating - inhibition of shivering, thermal tachypnea and cutaneous vasodilatation - was abolished 4 min after the end of spinal cord heating, when vertebral canal temperature had reached a normal value.

Six days after the partial cordotomy, the animal was killed, and Marchi's stain was performed of the spinal cord. Figure 2 shows a transverse section of the cord, 2 segments rostral to the transection level. In Figure 2A, numerous dark, small clots, which correspond to the myelin of degenerated fibers, cover the area of both dorsal funiculi. A few grey spots are interspersed between the degenerated myelin, especially at the left side medial to the entrance of a dorsal root. Apparently, they represent intact fibers, which have entered through the dorsal roots above the transection. The dark clots are, however, almost lacking in the adjacent parts of the lateral funiculi. The histological differences between these intact lateral funiculi and the degenerated dorsal funiculi are demonstrated in detail in Figure 2B. The clots of degenerated myelin are stained intensely, while the myelin sheaths of the intact fibers are visible as faintly stained annular structures.

Such a combined response to spinal cord heating below the level of bilateral transection of the dorsal funiculi has been confirmed in 19 out of 20 investigated animals. However, in all cases - up to now 6 animals - in which the ventrolateral funiculi had been cut bilaterally, afferent influences of spinal cord heating below transection on respiration and on cutaneous blood flow of the ear

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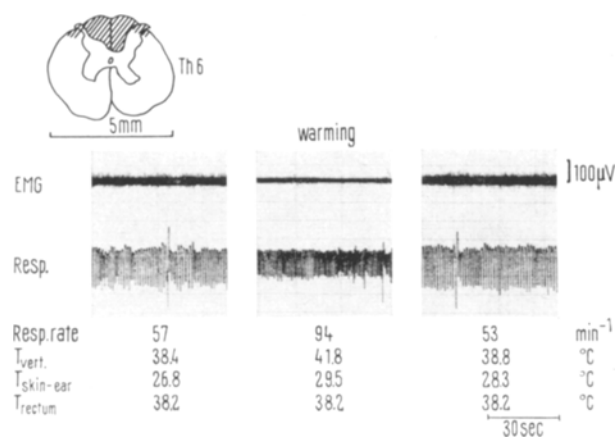


Fig. 1. Evocation of thermal panting and peripheral vasodilatation and inhibition of spontaneous shivering by selective warming of the spinal cord in a lightly anaesthetized rabbit (DF-20) which had been submitted to partial cordotomy of both dorsal funiculi at Th6. The hatched part of the inset shows the transected region of the spinal cord. Experiment of 7 May 1968. Constant ambient air temperature at 24°C.

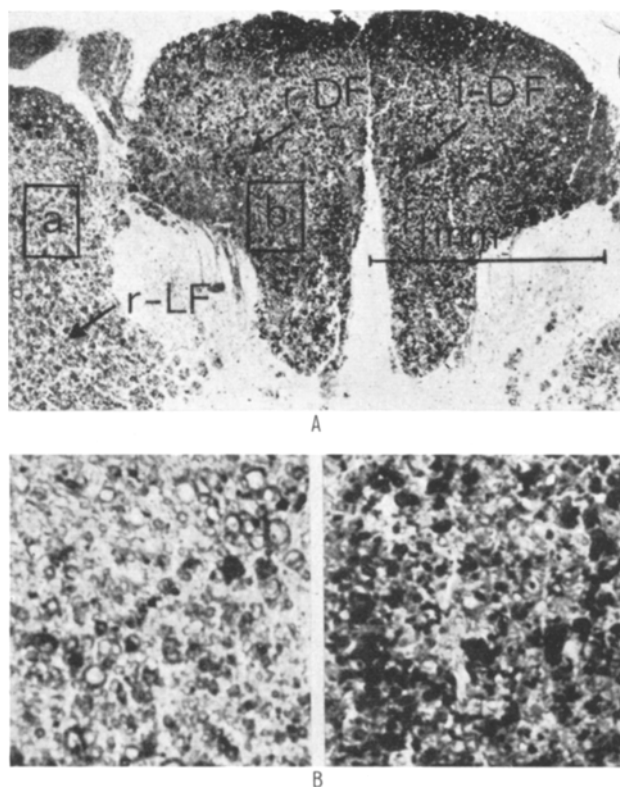


Fig. 2. (A) Transverse section of the spinal cord at the fourth thoracic segment showing degenerated ascending fibers located bilaterally in the dorsal funiculus. Same rabbit as in Figure 1. r-DF, l-DF, the right and left dorsal funiculus. r-LF, the right lateral funiculus. (B) Ascending fibers of the intact lateral funiculus (a) and the transected dorsal funiculus (b). The compact dark dots indicate the degenerated fibers. Enlarged (4 ×) sections of Figure 2A (a and b).

were lacking. Shivering, on the other side, could be evoked by spinal cord cooling below the transection level under this condition.

Conclusions. The experiments indicate that the signals arising from thermal stimulation of the spinal cord are conducted to higher spinal and to supraspinal thermoregulatory effector systems by afferent fibers which run in the ventrolateral, but not in the dorsal portions of the

spinal ascending tracts. This corresponds to the observation of WÜNNENBERG and BRÜCK² that shivering induced by external cooling is not inhibited by heating the lower cervical and upper thoracic spinal cord, if the ventral funiculi are transected at a higher cervical level. — These findings are parallel to the observation that the inhibitory effect on shivering of skin pressure is no longer present after contralateral transection of the ventrolateral funiculus at a higher level, i. e. after transection of the so-called ventral spinothalamic tract³. Likewise, it has been observed that modifications of electrocortical activity following thermal stimulation of the skin or following changes of environmental temperature are abolished, if the ventrolateral funiculi are transected at the cervical level⁴. — It may be suggested, therefore, that the afferent signals arising from spinal thermosensitive structures might follow the same ascending pathway as do the discharges of peripheral thermometers⁵.

Zusammenfassung. Der Einfluss thermischer Reizung des Rückenmarks unterhalb einer Teildurchschneidung in Höhe von Th4–Th11 auf Atmung, Hautdurchblutung und motorische Aktivität wurde an leicht narkotisierten Kaninchen untersucht. Mittels Marchi-Färbung einige Tage nach Durchschneidung wurden die ausgeschalteten afferenten Bahnen ermittelt. Nach Durchschneidung der Hinterstränge und anschließender Abschnitte der Seitenstränge konnte durch Rückenmarkswärmung unterhalb der Durchschneidung eine thermische Tachypnoe und eine Hautvasodilatation oberhalb der Durchschneidung ausgelöst werden. Diese Reaktion war nach Durchschneidung der Vorderseitenstränge erloschen.

M. KOSAKA, E. SIMON,
O.-E. WALTHER and R. THAUER

W.-G.-Kerckhoff-Institut der Max-Planck-Gesellschaft, 635 Bad Nauheim, and Physiologisches Institut der Universität Giessen (Germany), 20 September 1968.

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⁵ The authors wish to express their appreciation to Prof. A. OKSCHI, Giessen, for his helpful criticism of the histological findings.