tous les cas, par l'étude anatomique de la région lombo-vertébrale qui a pu être pratiquée 13 fois de façon très complète. L'examen macroscopique le plus souvent ne décèle rien, hormis quelques cas où l'on remarque un aspect œdémateux des masses sacro-lombaires qui sont pâles, bombantes en masse, ou bosselées. L'histologie est par contre très caractéristique, révélant toujours une infiltration leucémique massive des muscles, des vertèbres lombaires et du canal rachidien, refoulant la moelle épinière en arrière.

Les coulées de cellules leucémiques qui semblent se constituer dans la moelle osseuse vertébrale rompent la corticale osseuse et s'infiltrent en avant entre les faisceaux musculaires qu'elles dissocient. En arrière, elles pénètrent le canal rachidien, ou les méninges sont atteintes massivement; mais la moelle épinière elle-même est rarement infiltrée, elle est le plus souvent seulement refoulée en arrière. Par contre, les nerfs rachidiens et les ganglions sympathiques sont englobés et parfois pénétrés par l'infiltration leucémique. Les parois vasculaires de l'aorte et surtout des veines prévertébrales peuvent être envahies, mais généralement l'infiltration ne dépasse pas en avant l'aponévrose qui recouvre les muscles lombaires. Les chaînes ganglionnaires en particulier sont respectées. En hauteur, l'envahissement leucémique atteint le rachis lombaire et souvent le rachis sacré mais ne remonte pas jusqu'aux vertèbres dorsales. L'encéphale comporte inconstamment des infiltrats leucémiques méningés ou intracérébraux.

Les paralysies nous paraissent essentiellement liées à la compression de la moelle épinière par la prolifération cellulaire leucémique. En outre, le rôle de l'atteinte musculaire directe est probablement très important. La constatation de ces lésions massives contraste avec les observations de Stansly[2] qui n'a trouvé aucune prolifération leucémique périvertébrale ou médullaire capable d'expliquer les paralysies qu'il observe chez les souris Balb/c inoculées avec le virus de Stansly.

L'existence d'un virus neurotrope contaminant notre souche de virus de Gross est peu probable devant de telles lésions anatomiques et la latence prolongée du phénomène. En outre, nous avons cherché, sans succès, à mettre en évidence un tel virus par passage intracérébral chez le rat nouveau-né, ou le souriceau C_3H/eB et Balb/c. Aucune encéphalopathie n'a été observée. On a également cherché à isoler un virus du cerveau, de la moelle épinière et du sang des animaux paralysés. Les extraits de ces organes ont été inoculés sans succès à des cultures de fibroblastes embryonnaires de souris et de rats.

Summary. Inoculation of Wistar CF rats with Gross virus induces in 86% of the animals a leukaemia which is associated, in nearly 50% of the cases, with a paralysis of the hind legs.

This paralysis is due to the compression of the spinal cord by leukaemic cell infiltrates which develop in the lumbar area. No neurotropic virus has been found in these animals.

J. P. Levy, J. Lasneret,
J. Peries et M. Boiron

Laboratoire d'Hématologie Expérimentale, Institut de Recherches sur les Leucémies, Hôpital Saint-Louis, Paris (France), le 9 juin 1964.

Polysynaptic Activation of Extensor Motoneurones from Group Ia Fibres in the Cat Spinal Cord

Group Ia fibres, originating from the mammalian muscle spindles, make direct contact with motoneurones. An afferent volley carried by these fibres thus produces in motoneurones the excitatory postsynaptic potential (EPSP) monosynaptically. There is an extensive literature on this monosynaptic EPSP and the spinal reflex discharges thereby produced. The question, however, remains whether the excitatory action of Group Ia fibres is mediated exclusively by the monosynaptic pathway, as pointed out by Granit[1]. Actually, though in rare cases, Eccles, Eccles, and Lundberg[2] observed polysynaptic EPSPs produced by Ia afferent volley. In the experiment reported here, motoneuronal discharges induced synaptically from Ia afferent volleys were recorded through the ventral root filament in unanaesthetized, decerebrate cats, and the frequency distribution of the latency at which unit reflex discharges occur was examined. It will be shown that there are two distinct groups of motoneurones, one of which is excited only monosynaptically, while the other receives monosynaptic as well as polysynaptic activation from a synchronized volley in Group Ia fibres.

Cats were decerebrated by intercollicular section under ether anaesthesia. Laminectomy was done from L2 to L7 segmental level. The L7 or S1 ventral root was cut and its central portion was split into filaments which were mounted one at a time on a recording electrode of paired silver wires (R1, Figure 1). From the S1 or L7 dorsal root, a thin filament was separated, being cut near its entry into the cord. Its peripheral portion was mounted on another recording electrode (R2 in Figure 1). Care was taken that the severance of the dorsal root filament did not reduce by too much the total afferent inflow into the cord. Reflex discharge recorded from the ventral root filament was amplified by a capacitance coupled amplifier (time constant, 0.1 sec). Unit reflex discharges were searched for from filament to filament. By recording from the dorsal root filament, the intensity of stimulation was adjusted to stimulate only half of Group I fibres, almost all of which were presumed to belong to Group Ia fibres[3]. Nerves innervating medial gastrocnemius (MG), lateral gastrocnemius plus soleus (LGS), and plantaris (P) were dissected and mounted on stimulating electrodes (S1, S2, S3 in Figure 1 inset diagram). The nerves were stimulated by applying square pulses of duration of 0.1 msec at a rate of 10 to 70 cps.

Figure 1 A, B illustrates reflex discharges evoked by repetitive LGS stimulation at 40 cps. The records were formed by superposition of about twenty traces which were triggered at the time of each stimulus. In A the reflex discharges occurred in about half of the trials at a constant latency of 3.0 msec. In B, on the other hand,

1 R. Granit, *Receptor and Sensory Perception* (Yale University Press, New Haven and London 1955).

2 J. C. Eccles, R. M. Eccles, and A. Lundberg, J. Physiol. *154*, 89 (1960).

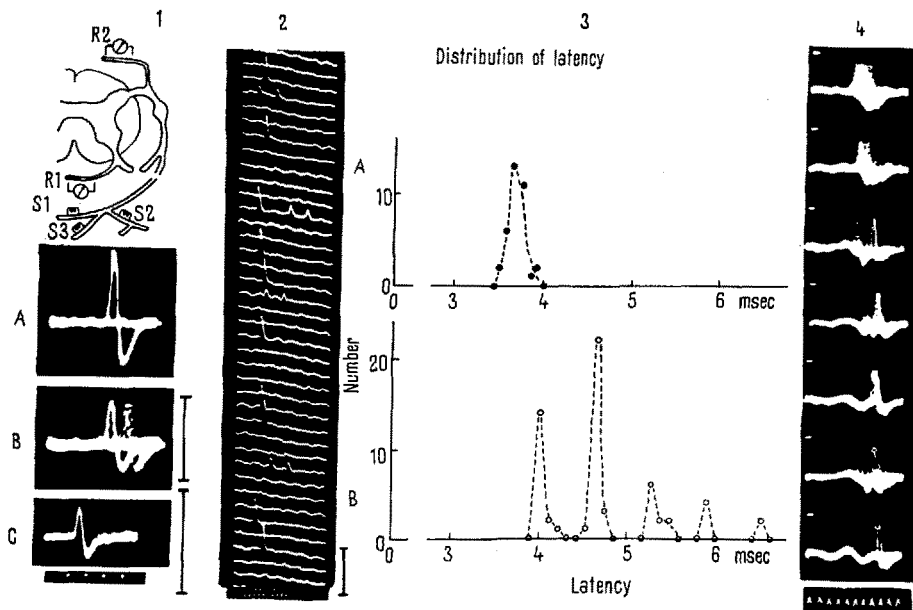3 K. Bradley and J. C. Eccles, J. Physiol. *122*, 462 (1953).

Fig. 1. Showing arrangements of recording from S1 or L7 ventral root filament (R1), and from the S1 or L7 dorsal root filament (R2), and of stimulating ankle extensor muscle nerves (S1, S2, S3). Time scale, 1 msec. Voltage scales, 1 mV.

Fig. 2. Time scale, 1 msec. Voltage scale, 1 mV.

Fig. 3. Ordinates, number of unit spike discharges. Abscissae, latency of the discharge.

Fig. 4. Time scale, 1 msec. Voltage scale, 1 mV.

spikes appeared not only at the latency of 3.2 msec, but also, though less frequently, at 3.7 to 4.0 msec. These two types of unit responses in Figure 1 A and B were obtained in one and the same animal and by the same stimulus intensity which was adjusted so as to excite 60% of Group I fibres in the LGS nerve. The afferent volley recorded from the dorsal root filament is shown in Figure 1 C. The earliest discharges in these two types of unit responses occurred with approximately the same latencies, 3.0 msec and 3.2 msec, respectively, and presumed to be induced through the monosynaptic pathway. Figure 2 shows another example of unit reflex response with fluctuating latency. The P muscle nerve was stimulated at 50 cps and reflex discharges thereby produced were recorded on moving film, each sweep being triggered by the stimulating pulse. The motoneurone did not follow every stimulus but responded on the average once to every 4 stimuli. The latency for each reflex discharge was measured in the series partly shown in Figure 2 by the time from the stimulus to the foot of the spike. The latency distribution during 2.5 sec of sustained stimulation is plotted in Figure 3 B. It is seen that there are five peaks of the latency distribution separated from each other by about 0.6 msec. In contrast, in the case of Figure 3 A, the reflex response to the LGS stimulation at 50 cps showed latency distribution with only one peak. Excitation of motoneurones with fluctuating latency, such as shown in Figure 3 B, would suggest that they received not only monosynaptic but also polysynaptic activation. Variation of latencies by 0.6 msec steps is explicable in terms of the synaptic delay; when a group of motoneurones fails to be activated by monosynaptic volleys, they would have another opportunity to be excited by polysynaptic volleys, which are delayed by intervals of 0.6 msec steps. This view is strongly supported by the fact that, when a small dose of pentobarbital sodium (5 mg/kg) was injected intravenously, the delayed responses disappeared, for this drug is well known for depressing the polysynaptic reflexes. In Figure 3 B the frequency was highest at the second shortest latency. However, the frequency distribution of the latencies usually altered during prolonged stimulation. For example, in Figure 4, the P nerve was stimulated during 7 sec at 70 cps and thereby induced unit reflex discharges were sampled every 1 sec by superposing initially 20 successive sweeps triggered by the

stimuli. From top to bottom, there was a progressive decrease of the frequency of the reflex occurrence and the latency of the highest frequency shifted from 4 msec to 7 msec. Thus, in the bottom record of Figure 4, Group I afferent volley induced only delayed reflex discharges. In the cases with only one peak of the latency distribution, such as seen in Figures 1 A and 3 A, the frequency of reflex occurrence decreased rapidly during stimulation and diminished after about 2 sec. In this sense these units are phasic, while those with delayed responses, such as in Figures 1 B and 4, are tonic, for they maintain these discharges over about 10 sec. So far 50 units have been specified as tonic. Out of these, 20 are excited by stimulating P, 11 by LGS, 16 by MG and 3 by LGS plus MG. Exact comparison was not made, but it was the general impression that the phasic type of responses was encountered under the stimulation of any of these muscle nerves at comparable frequencies with the tonic one.

In conclusion, the extensor motoneurones can be classified into two groups by their response patterns to Group Ia volleys: one is activated only monosynaptically and phasically, while the other is excited both mono- and polysynaptically in a tonic fashion. This finding stresses the importance of the polysynaptic connection in the naturally occurring stretch reflexes which are mediated by Group Ia fibres, in accordance with the earlier suggestion of GRANIT[4].

Résumé. Chez le chat décérébré, les réponses unitaires des neurones moteurs sont évoquées par la stimulation répétitive des Group Ia fibres des nerfs musculaires extenseurs. Il a été montré deux types des réponses par rapport à les latences et les façons des décharges.

N. TSUKAHARA[5] and C. OHYE

Section of Neurophysiology, Institute of Brain Research, Faculty of Medicine, University of Tokyo (Japan), June 23, 1964.

[4] R. GRANIT, C. G. PHILLIPS, S. SKOGLUND, and G. STEG, J. Neurophysiol. *20*, 470 (1957).
[5] Present address: Department of Physiology, Faculty of Medicine, University of Tokyo (Japan).