On the Function of Corticothalamic Neurons

Abstract: The effect of the synchronous discharge of a large population of corticothalamic neurons on activity within the somatosensory relay nuclei has been studied. Thalamic responses to peripheral nerve stimulation are depressed by activity in corticothalamic neurons. A subconvulsive dose of strychnine, given intravenously, changes this depression to enhancement.

The existence of corticothalamic neurons projecting from the cortical receiving areas to the specific thalamic relay nuclei has been recognized for many years, yet little is known of their physiological significance. In order to study the function of these cells it is necessary to activate them in large numbers and synchronously, yet selectively, without firing the nearby thalamocortical neurons antidromically. This may be achieved through the application of penicillin to the cortex as a means of initiating a repetitive high-voltage cortical discharge, the "penicillin spike." It is the purpose of this communication to describe marked alterations in the amplitude of thalamic-evoked responses elicited after a penicillin spike. Forty-seven cats deeply anesthetized with Nembutal were used in this study.

After stimulation of the somatosensory pathway it is possible to record an evoked response from the ventrobasal thalamus: a brief, initially positive, diphasic spike followed by a small negative and a large, slow positive wave. If this thalamic response is initiated during or after a cortical penicillin spike, the negative and late positive waves are greatly reduced or abolished, provided the penicillin spike was generated in the specific cortical receiving area of the nucleus from which the recording was made. Thus, the application of penicillin to somatosensory cortex I generates penicillin spikes which markedly depress the ventrobasal thalamic responses to stimulation of the sciatic or radial nerve or the medial lemniscus. On the other hand, penicillin spikes generated in the auditory or visual cortex have no effect on the responses evoked in the ventrobasal thalamic nuclei.

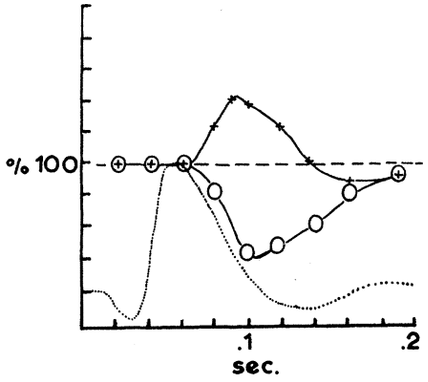

Fig. 1. Effect of the penicillin spike on the ventrobasal thalamic response to stimulation of the medial lemniscus before (circles) and after (crosses) intravenous administration of 0.1 mg of strychnine per kilogram. (Vertical axis) Average amplitude of the late positive wave from 50 thalamic responses represented as a percentage of the control value. (Horizontal axis) The penicillin spike (dotted line) diagrammatically displayed against time.

An important clue to the mechanism by which a cortical discharge may depress thalamic activity is seen in the effect on such activity of a subconvulsive dose of intravenous strychnine. Three to four minutes after intravenous administration of 0.1 mg of strychnine per kilogram, the penicillin spike, rather than depressing the thalamic-evoked response, actually enhances the late positive wave. This is illustrated in Fig. 1. The amplitude of the late positive wave of the ventrobasal thalamic response to medial lemniscal stimulation is represented on the vertical axis as a percentage of the control value. Each point represents the average of 50 responses. On the horizontal axis the cortical penicillin spike in shown diagrammatically (dotted line). It may be seen that before the administration of strychnine the thalamic test response is greatly depressed when it is elicited after the peak of the cortical penicillin spike (circles). Five minutes after the intravenous administration of 0.1 mg of strychnine per kilogram, the depression is abolished and the thalamic response is greater than for the control (crosses). Neither the penicillin spike itself nor the thalamic-evoked response alone is affected by the strychnine.

The possibility that the thalamic depression is caused by activation of the brainstem reticular formation (see *1*) is considered unlikely because of the depth of the anesthesia used. A second possibility, that the thalamic depression is due to antidromic backfiring of thalamocortical neurons, is also considered extremely unlikely because of the action of the strychnine in reversing the depression. Strychnine, in the amount used here, has been shown to be very effective in blocking inhibitory synapses in the spinal cord of the cat (*2*). Since synapses would not be involved in thalamic depression caused by antidromic activation of thalamocortical neurons, it is inferred that the depression is in fact mediated trans-synaptically through corticothalamic neurons. A reasonable hypothesis to explain the above observations is that the penicillin spike activates corticothalamic neurons with both excitatory and inhibitory thalamic synapses, the latter being predominant. The strychnine, in selectively blocking the inhibitory synapses, abolishes the depression of thalamic activity which they cause and permits expression of the previously masked, less potent excitatory activity. It is suggested that the corticothalamic projection system may provide a form of inhibitory sensory feedback which could function to reduce the subliminal fringe about a zone of maximal excitation in the thalamus. This might serve to distinguish the boundaries between one such zone and another and provide a form of sensory "focusing" (*3*).

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3. This study was supported by a grant from the European Research Office, U.S. Department of the Army.

14 August 1959

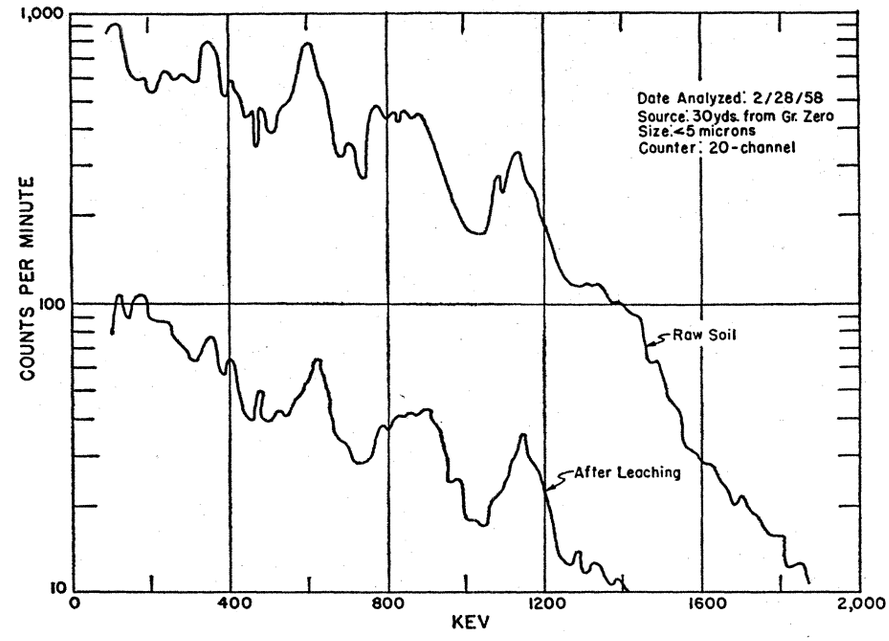
Occurrence of Scandium-46 and Cesium-134 in Radioactive Fallout

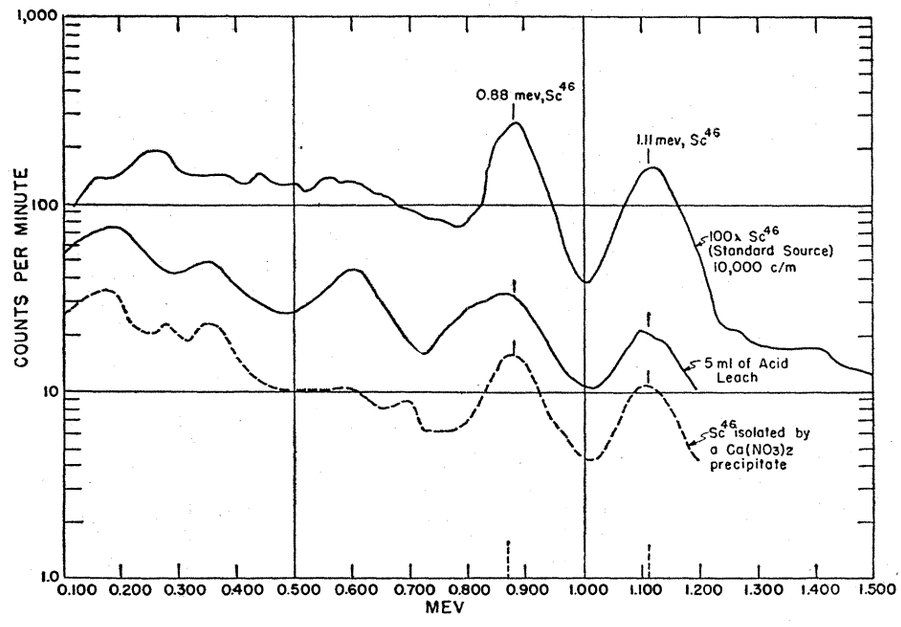
Abstract. Two hitherto unreported induced radionuclides, scandium-46 and cesium-134, have been detected in fallout material. Identification was made by chemical separation and gamma scintillation spectrometry. While the origin of these materials is not known, possible routes of formation from stable elements are suggested.

Soil samples (*1*) collected a few yards from ground zero by vacuum sweeping after an atomic detonation (balloon shot) in Nevada were sent to the Robert A. Taft Sanitary Engineering Center for radiochemical analyses.

An analysis of the gamma spectrum of an aliquot of the soil was made approximately 60 days after collection. After digestion and leaching of activity presumably fused on the soil, an aliquot of the leach solution was simultaneously analyzed. The gamma spectra are shown in Fig. 1; they indicate the presence of gamma emitters whose energies are near 0.6, 0.8 to 0.9, and 1.1 Mev, respectively. According to data calculated by Hunter and Ballou (*2*), the predominant fission-product contributors to the total activity 60 days after detonation should be Zr^{95}-Nb^{95}, Ce^{141}, Y^{91}, and Sr^{89}. Since none of these nuclides has gamma energies corresponding to the photopeaks observed, analyses of the important fission products for specific radionuclides were performed.

After separation (*3*) of the major fission products—strontium, cesium, zirconium-niobium, and rare earths—we were unable to assign the 0.9 and





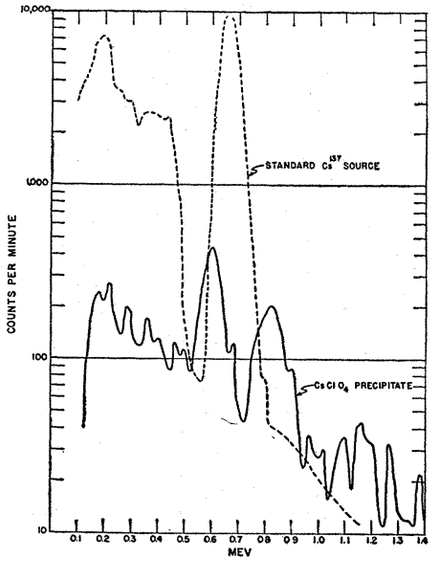


Fig. 1 (top). Gamma spectra for fallout mixed with water and acid leach. Fig. 2 (middle). Gamma spectra for activity in standard Sc^{46} source, in acid soil leach, and in chemically isolated Sc^{46} from soil collected 30 yd from ground zero. Fig. 3 (bottom). Comparison of gamma spectra of standard Cs^{137} source and of final $CsC10_4$ precipitate.

the 1.1 Mev gamma energies, or to account for all the activity present. Manganese-54, iron-59, and zinc-65, previously reported in fallout, were eliminated as possibilities after radiochemical analyses to obtain each of these gamma emitters in a purified form. Eventually, the possibility that both peaks might be attributable to Sc^{46} was suggested (*4*).

Attempts to separate scandium by reported methods (*3,5*) failed, possibly because yttrium was used as a carrier in the absence of stable scandium. It was found, however, that most of the gamma activity at 0.9 and 1.1 Mev was carried on $Ca(NO_3)_2$ precipitated by fuming nitric acid. Known Sc^{46} tracer was also carried by this treatment. This purification step permitted identification of the unknown emitter as Sc^{46} by its gamma spectrum. The spectra, shown in Fig. 2, show the agreement with the known Sc^{46} photopeaks at 0.88 and 1.11 Mev. (*6*). The Sc^{46} content, estimated from the area under the photopeaks, accounted for approximately 40 percent of the total activity leached, or for most of the previously unidentified activity.

The cesium fraction, which had been carefully purified (*7*), showed prominent gamma peaks at 0.6 and 0.8 Mev, with only a slight indication of the expected peak at 0.66 Mev. In Fig. 3 the spectrum of a standard Cs^{137} source is compared with that of the $CsC10_4$ precipitate, and the difference in the photopeaks is apparent. The 0.6 and 0.8 Mev peaks correspond to those of Cs^{134} (*6*).

Without knowledge of the past history of this soil, it is difficult to explain the presence of Sc^{46} and Cs^{134}. Since no soil from this area had been chemically analyzed prior to this particular test, information on its composition is not available, specifically with respect to the presence of stable scandium or cesium. If it is assumed that these activities were induced during a nuclear explosion, possible reactions for production of Cs^{134} would be:

$$Cs^{133}\ (n, \gamma)\ Cs^{134}$$
$$Ba^{134}\ (n, p)\ Cs^{134}$$
$$Ba^{136}\ (n, t)\ Cs^{134}$$

Similarly, Sc^{46} might be produced by the reactions:

$$Ti^{46}\ (n, p)\ Sc^{46}$$
$$Sc^{45}\ (n, \gamma)\ Sc^{46}$$
$$Ti^{48}\ (n, t)\ Sc^{46}$$

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* Assigned to the Robert A. Taft Sanitary Engineering Center from September 1957 to January 1958.

23 April 1959

Degree of Obesity and Serum Cholesterol Level

Abstract. No significant correlation was found between the serum cholesterol level and weight, weight corrected for frame size, or thickness of the fat shadow in medical students (mean age, 22 years).

Among the variables thought to affect serum cholesterol levels in normal subjects, the degree of obesity has been of particular interest because the amount of stored fat is accessible to dietary control. The literature, however, is divided on the relationship of body fat to cholesterol level. Moreover, reports have been variously based on anthroposcopic "endomorphy" ratings (*1, 2*), weight or relative weights (*3*), indices of body build (*4*), or infrascapular fat folds (*1, 5*) and not, to our knowledge, on direct radiographic measurements of the outer-fat shadow.

In the study reported here we compared the thickness of the fat-plus-skin shadow, measured at the level of the tenth rib on standard posteroanterior teleoroentgenograms (*6*), with serum cholesterol levels, determined, by a modification of the Bloor method (*7*), in blood samples obtained at the time the roentgenograms were made. Less direct measures of relative obesity included weight, and weight expressed in relation to the bony-chest diameter, as measured on the films. Replicability was 0.95 for the fat measurements (*8*) and 0.92 for serum cholesterol (*7*).

Table 1. Correlations between various measures of obesity and total serum cholesterol in healthy young men.

N	Mean body wt. (kg)	Serum cholesterol (mg/100 ml)*	Correlation (*r*)
		Body weight	
159	74.8	225.2±36.3	0.033
		Body weight/chest breadth	
134	73.4	226.0±37.8	0.126
		Lower thoracic fat	
125	73.2	222.5±34.2	−0.030

* Mean ± standard deviation.

Subjects included the 159 white male medical students in the classes of 1958, 1959, and 1960 of the Johns Hopkins School of Medicine, for whom body weight, cholesterol level, and posteroanterior chest plates were obtained at the time of admission. The mean height for the group was 178.9 cm, the mean weight was 74.8 kg, and the mean age was 22 years. The cholesterol range was 140 to 386 mg/100 ml with a mean of 225 mg/100 ml, and the lower-thoracic fat range for the subjects in whom the fat-plus-skin shadow could be accurately measured was 2 to 15 mm, with a mean of 7.4 mm.

As shown in Table 1, the correlation between serum cholesterol level and weight in the series of 159 men was not significantly different from zero at the 5-percent level of confidence ($r = 0.13$). In a restricted subsample, from which subjects whose radiographs were not suitable for the chest-breadth measurement had been excluded, the correlation between serum cholesterol and weight corrected for build was similarly low ($r = 0.13$). Finally, the correlation between serum cholesterol and lower-thoracic fat, measured on 125 radiographs technically suitable for the purpose, was −0.03. It is noteworthy that the mean cholesterol levels and their standard deviations in the total sample and in the partial samples were very nearly the same. The ranges for the three groups were identical.

There are many factors in addition to nutritional status which have been shown to be related to the height of the serum-cholesterol level of healthy persons—in particular, age, sex, race, heredity, endocrine patterns, habits of smoking and exercise, and degree of emotional stress. We have reported positive correlations between several of these factors and high cholesterol levels among the Johns Hopkins medical students (*9*). The lack of relationship between the amount of body fat and the serum cholesterol level demonstrated in the present study supports the view that the nutritional status of healthy young men such as medical students is considerably less important in determining the cholesterol level than other biologic factors (*10*).

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19 August 1959

Neural and Hypophyseal Colloid Deposition in the Collared Lemming

Abstract. Feral and captive lemmings from Churchill, Manitoba, are subject to a unique pathological process in which a colloidal material is deposited in blood-vessel walls at scattered points through the central nervous system. Destruction of nervous tissue at these foci is progressive, and colloidal masses in the vascular lumina of the hypothalamus appear to become fixed in the capillaries of the hypophyseal anterior lobe. Inflammatory reactions are never associated with the lesions, and the latter are larger and more numerous in older animals in warmer environments.

A current study of the microanatomical and physiological characteristics of the collared lemming (*Dicrostonyx groenlandicus* Traill) has revealed a unique and previously unknown pathology which is probably a significant factor in the behavior and population fluctuations of these ecologically significant arctic rodents.

Lemmings used in this study consist both of animals fixed in 10-percent neutral buffered Formalin immediately after capture at Churchill, August 1953 and July 1954, and captives and their progeny perfused and fixed in Bouin's fluid. Observations on the behavior, reproduction, growth, diseases, and reproductive and endocrine organs of these animals have been presented (*1*). Captive lemmings were raised and maintained usually in an artificially and constantly lighted room at 24°C (21° to 27°. Groups of animals were periodically transferred to darkness and a temperature of 23°C for 4 months, or to a thermostatically controlled deep-freeze cabinet with a transparent lid and forced circulation of air. After 10