Sustained Response of the Diffuse Thalamic Projection System.* (29212)

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Low frequency stimulation of certain intralaminar and midline thalamic nuclei produces recruiting responses in certain regions of the cerebral cortex(1,2,3). Depending upon stimulation and recording sites, primary sensory evoked potentials of 1-2 msec. latency and augmenting responses of 5-15 msec. latency may be observed in addition to recruiting responses(4). Slightly suprathreshold stimulation for recruiting responses results in the appearance of evoked potentials following the frequency of stimulation which do not wax and wane(2).

In the present experiments, cortical recruiting was elicited by 6-10/sec stimulation of the following thalamic nuclei: centrum medianum, centralis lateralis, ventrolateral portion of dorsomedialis, ventralis anterior, ventralis lateralis, ventralis medialis, lateralis posterior and reticularis. Responses were recorded with an inkwriter and oscilloscopically monitored. The latency of the recruiting wave varied from 20-60 msec., but was quite constant from a given site of stimulation. We focused our attention upon the responses of constant amplitude which continued between episodes of recruiting during thalamic stimulation. These had the same latency and wave form as the recruiting responses and for convenience of description we shall refer to them as the "sustained" response.

Most of the 31 cats used in this study were anesthetized by barbiturates but in some cases surgical or radio-frequency midcollicular lesions were made. After being immobilized by Flaxedil (gallamine triethiodide), the animals were maintained on artificial respiration.

Typical recruiting may or may not accompany the sustained response. When recruiting was present, the sustained responses were generally confined to the cortical region showing the highest amplitude recruiting. Both the sustained response and the recruiting response were recorded from the white matter underlying the cortex after the cortex had been removed. Recruiting responses did not occur at stimulating frequencies above 10-12/second, but the sustained response followed, with diminished amplitude, at frequencies up to 20/second. The relative preponderance of recruiting or sustained responses was related both to stimulus intensity and the level of consciousness of the animal. In locally anesthetized, immobilized preparations both responses usually occurred together (Fig. 2). Administration of 5-10 mg/kilo sodium pentothal substantially raised the threshold of the sustained response and lowered that of the recruiting response (Fig. 1), even in animals with a mesencephalic transection. Conversely, when the animals showed electrocortical low voltage fast activity, recruiting disappeared but the sustained response persisted. Fifty or 100/second stimulation (0.3 ma; 0.5 msec. pulse duration) throughout the lateral hypothalamus, but particularly the posterior portion, usually abolished the recruiting response but not the sustained response (Fig. 2). Stimulation of the mesencephalic reticular formation, subthalamus, and pretectal area produced the same effect as stimulation of the hpyothalamus.

Recording and stimulating through chronically implanted electrodes, we could evoke both recruiting and sustained responses in a quietly sitting, awake cat. When the animal was alerted by a noise or was active, only sustained activity was seen.

Cortical spindles elicited by caudate stimulation(5) did not have a sustained component, nor did they influence the recruiting and sustained thalamo-cortical activity. Hypothalamic stimulation inhibited the caudate induced cortical spindle.

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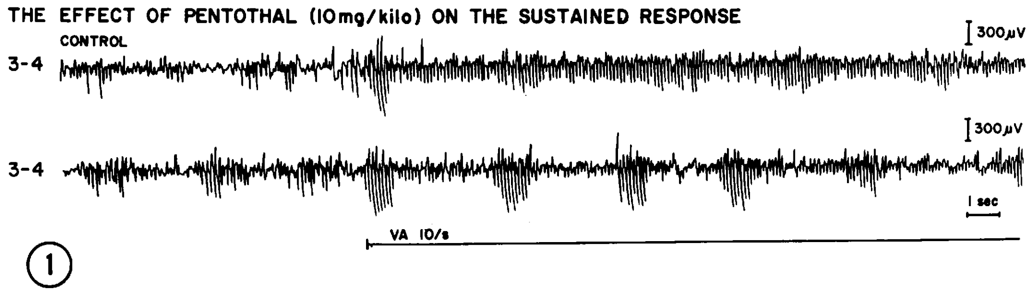
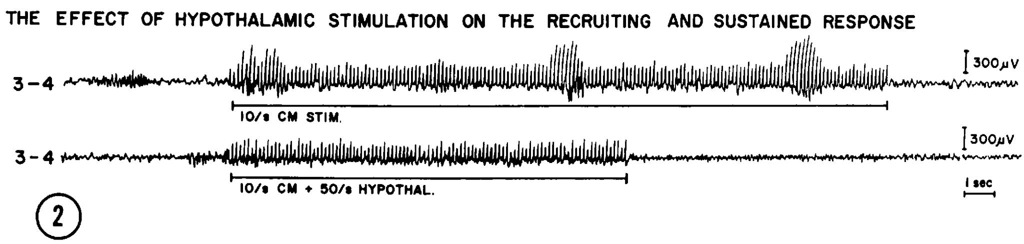
Synchronization of the EEG was produced by low frequency (1/5 second and 5/second), broad pulse (5.0 msec. pulse duration) stimulation of the caudal brainstem reticular formation(6,7). Such brainstem stimulation also produced synchrony in the thalamic nucleus ventralis anterior but did not affect recruiting or sustained activity in the cerebral cortex (Fig. 3). Stimulation of these same brainstem areas at high frequency suppressed or abolished the recruiting response and did not affect the sustained response.

Stimulation throughout the preoptic area at a variety of stimulus parameters failed to produce synchronization of the EEG(8), and had no effect upon the recruiting or sustained activity.

The influence of stimulation that produced





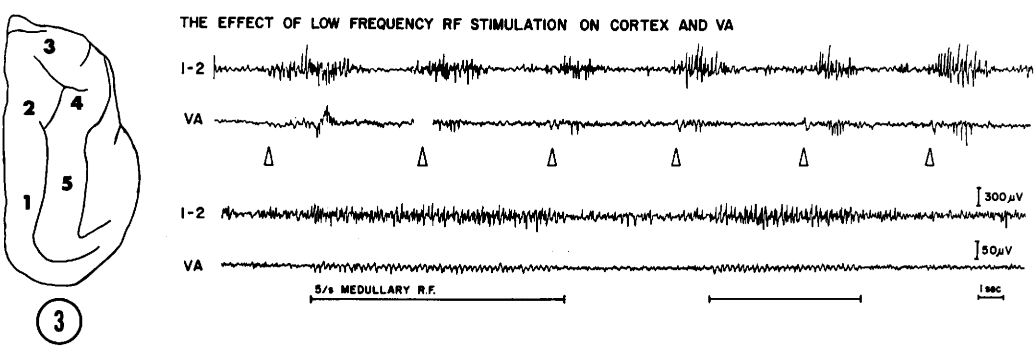


FIG. 1. Upper channel: Recruiting and sustained responses produced in a lightly anesthetized cat by 10/sec stimulation of thalamic nucleus ventralis anterior (VA). Lower channel: Same, several minutes after intrathoracic administration of 10 mg/kilo sodium pentothal. Note suppression of sustained response and enhancement of recruiting response. 3 = posterior sigmoid gyrus; 4 = anterior suprasylvian gyrus. See map, Fig. 3.

FIG. 2. Upper channel: Recruiting and sustained responses produced by 10/sec stimulation of thalamic nucleus centrum medianum (CM). Lower channel: Simultaneous 50/sec stimulation of posterior hypothalamus and 10/sec CM stimulation. Recruiting response but not sustained response is abolished.

FIG. 3. Synchronization of electrocorticogram and in thalamic nucleus ventralis anterior (VA) produced by low frequency stimulation [one every 5 sec in upper pair of traces (△); 5/sec in lower pair] of nucleus reticularis ventralis of medullary reticular formation. Map indicates location of cortical recording electrodes.

cortical low voltage fast activity on the recruiting response was first described by Moruzzi and Magoun(9). Recruiting responses that are abolished by "alerting" stimuli(10), have been observed in the awake, unanesthetized relaxed animal(11). Recently recruiting responses in awake, alert preparations have been illustrated with what appears to be a sustained response(12). In the present experiments, care was taken to distinguish between recruiting and augmenting responses in the oscilloscopically monitored recording. The sustained responses we have described are related to the long latency recruiting cortical evoked potential and were observed after cortical ablation, which has been shown to abolish the augmenting response(13).

Although the recruiting and sustained responses had a similar waveform, latency and distribution, they were affected differently by brainstem stimulation and barbiturate anesthesia.

The similarities of waveform, latency and distribution suggest that the same thalamocortical pathways are involved for recruiting and sustained responses. However, the differences in the effect of "alerting" stimuli or barbiturate anesthesia would indicate that only a portion of the diffuse thalamic projection system is altered by afferent fibers from the reticular formation and hypothalamus, or by barbiturate anesthetics.

Summary. When certain intralaminar thalamic nuclei are stimulated at intensities slightly above threshold for the cortical recruiting response, a response of similar wave form, latency and cortical distribution maintains a sustained amplitude between epochs of recruitment. This sustained response differs from the recruiting response in its reaction to reticular activating system stimulation and barbiturate anesthesia.

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Effect of Digitoxin, Aldosterone, and Dietary Sodium Chloride on Incorporation of Inorganic P^{32} into Liver and Kidney Nuclear and Mitochondrial Phospholipids.* (29213)

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There is evidence linking phospholipid metabolism with active transport. An increased turnover of phospholipids is known to be associated with the movement of secretory products out of cells stimulated by acetyl-

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