coincidence of carbon,hydrogen and molecular weight data, which are consistent with the concept of the product type being a simple, long-chain carboxylic acid, it seems unlikely that much, if any, polyester structure is present.

The reactants were charged to reaction vessels (American Instrument Co. Micro Series) having an approximate volume of 300 ml. Carbon dioxide was added in the solid phase and ethylene (99.5-percent purity) was quickly pressured into the bombs while still cold. Calculated initial pressures ranged from 1000 to 7500 lb/in.^{2} (gage), depending upon the temperatures employed. Gamma irradiations were made (see Table 1) to an approximate total dose of 1×10^7 r with a 6-Mev linear electron accelerator as an x-ray source (*2*). In experiments in which free radical initiators were used in lieu of radiation, the reaction was carried out at the decomposition temperature of the initiator.

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References and Notes

1. D. E. Sargent, U.S. Patent 2,462,680 to E. I. du Pont de Nemours and Company, Inc. (22 Feb. 1949).
2. The gamma irradiation was conducted at either the MTR Gamma Facility, Materials Testing Reactor, Idaho Falls, Idaho, or at the Radiation Laboratory, Phillips Research Center, Bartlesville, Oklahoma.

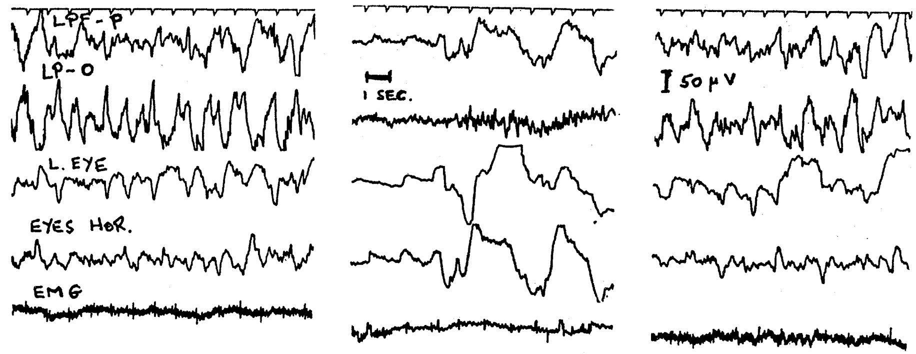
15 May 1961

Tonus of Extrinsic Laryngeal Muscles during Sleep and Dreaming

Abstract. The tonus of extrinsic laryngeal muscles was studied in sleeping humans by means of electromyograms. A striking decrease in the muscle tonus was observed at the onset of each phase of electroencephalographic light sleep, rapid eye movements, and dreaming.

Previous electromyographic (EMG) studies of muscle tonus during sleep in humans have found the resting potential to decrease when the subjects fall asleep, but no relationship was found between resting potential and the depth of sleep determined from the electroencephalograph (EEG) (*1*).

The aim of the present study was to investigate the high resting tonus of the laryngeal muscles during continuous sleep. Brain waves, eye movements, and electromyograms were recorded, by essentially the same procedure as that of Dement and Kleitman (*2*), in nine subjects for a total of 17 nights of continuous sleep.



1:57 A.M. 4:56 A.M. 5:28 A.M.

Fig. 1. Variation in laryngeal resting potential with depth of sleep. The EMG activity recorded during ocular quiescent deep sleep phases at 1:57 A.M. and 5:28 A.M. is markedly greater than that recorded at 4:56 A.M. during the intermediate dream period of light EEG sleep, with rapid eye movements clearly seen in the eye channels.

The electroencephalogram was recorded by means of an anteroposterior chain of electrodes affixed to the scalp with collodion. Eye movements in the horizontal plane were recorded by the electro-oculogram, by a central forehead electrode and a lateral pair made up of an electrode at each outer canthus, attached to the surface of the skin by means of sticking plaster.

Electrical activity in the laryngeal musculature was monitored by surface electrodes attached to the skin with sticking plaster over the supra- and infrahyoid muscles.

When the subjects fell asleep there was invariably a continual, discrete decrease in the EMG activity, until the appearance of sleep spindles and K-complexes. The EMG activity then tended to remain constant, apart from momentary increases associated with gross body movements, swallowing, or localized movements. These could be identified by means of a sensitive microphone at the head of the bed and by muscle artifact in the EEG and eye leads.

The depth of sleep, as indicated by the EEG, showed the typical cyclical pattern (*3*), with rapid eye movements occurring during the light phases of "A" and "B" stage sleep.

A rapid decrease in EMG activity was invariably observed, with the disappearance of sleep spindles, on the upswing of a sleep cycle from the "D" and "E" stages of deep sleep, through the "C" stage to the "A" and "B" stages, accompanied by rapid eye movements normally associated with dreaming. An example of this variation in EMG activity is shown in Fig. 1.

Jouvet *et al.* (*4*) have noted a similar variation of EMG activity in the nuchal muscles of cats during sleep. After a "slow" stage of sleep characterized by spindles and slow waves, there was a "rapid" sleep phase: the "paradoxical phase" which was characterized by a rapid, low-voltage, nonspindling electroencephalogram similar to that of wakefulness, accompanied by rapid eye movements and total disappearance of EMG activity. This phase is identified by Jouvet (in *5*, p. 204) with the "A" and "B" sleep stages, rapid eye movements, and dreaming in humans. This view has been contested by Schwartz and Fischgold (in *5*, pp. 225, 232), who maintain that there is an increase in oropharyngeal muscle tone with eye movements, on the grounds that snoring occurs extremely rarely during rapid eye movement periods, snoring being attributed to the loss of muscle tone in the soft palate.

It therefore appears from the present study either that the "A" and "B" sleep stages in humans are equivalent to Jouvet's "paradoxical phase" of "rhombencephalic sleep," or that the observed variation of muscle tonus during sleep is peculiar to the laryngeal muscles.

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7 July 1961