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Form of the Reflex Response in Relation to the Pattern of Afferent Stimulation.

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The contraction curve and the after discharge of the flexor reflex response to selective ipsilateral afferent stimulation were studied on 52 cats. Action potentials of the afferent impulses in the popliteal or saphenous nerve, tibialis anticus muscle reflex in spinal cats were recorded. In this group of experiments, discharges from a small condenser (.001 mf) furnished the stimulus. Larger condensers (.02 mf) were used in a second group of experiments which included also decerebrate animals. It was established that with the larger condensers repetitive firing of groups of fibers of the afferent nerve followed a single shock; only the lower threshold fibers fired twice with small voltages. As the strength of stimulus was increased, more of the fibers were repeatedly stimulated, while the higher threshold fibers were fired once. Large voltages repeated the entire action potential with each shock. With the small condenser discharges, a single stimulus fired only once all fibers within the threshold of that stimulus. The rate of stimulation varied from 1 to 15 per second, and in most instances periods of stimulation did not exceed 10 seconds.

Results. Voltages within the threshold range of the large fibers of the A group, including the alpha, beta and gamma fibers, produced excitatory responses in the contraction curve which persisted during the period of stimulation at a constant level. Cessation of stimulation resulted in prompt relaxation of the muscle, without indication of an after discharge. Action potentials indicated that alpha fiber threshold coincided with 1.5 v at .001 mf. The rest of the alpha, beta, gamma fibers of the A group were fired with shocks of 3-4.5 v.

Stronger voltages (6 v) produced a slightly stronger contraction, which decreased after an initial maximum. An after discharge was manifest in the delay in relaxation of the muscle at the conclusion of stimulation. Progressively stronger voltages produced initially stronger contractions which, however, fell off more rapidly during stimulation, and were followed, after stimulation stopped, by after discharges, occurring as separate slow contractions, a latent period intervening. With 6 volts the lower threshold fibers

of the delta wave discharged; with stronger stimuli, progressively more fibers of the delta wave were fired. The after discharge coincides with the stimulation of delta fibers, and its latent period becomes longer as the voltage increases.

Large condenser discharges resulted in variations of the contraction curve which could be interpreted in the light of repetitive firing of selective groups of fibers. Small voltages, particularly those near threshold, usually produced a contraction curve characterized by more or less fusion of individual contractions, and a persistent tendency to build up tension in the contraction curve. After discharges, if present, were immediate in type, with a very small latent period. As the voltage was increased, the contraction curve flattened out into a plateau, and with stronger stimuli the curve declined. After discharges showed a longer latent period as the stimulus was increased.

The build-up of tension is obviously the effect of excitatory fibers. The maintenance of a plateau is thought to indicate a balancing between excitatory and inhibitory stimuli. The decline in the contraction curve with strong stimuli is presumably caused by the preponderating effect of inhibitory impulses. The after discharge then appears because the inhibitory after effects cease more quickly than the excitatory after effects. The latency of the development of the contraction of the after discharge is due to the algebraic summation of inhibitory and excitatory after effects.

In these nerves the threshold for reflex contraction is not the threshold for the most excitable afferent fibers, but occurs near the maximum of the first wave in the action current record. Muscle tension increases throughout the range of delta fibers. Inhibitory effects are evident only with delta fiber stimulation. Therefore, while inhibition and excitatory ranges partially overlap, the large fibers tend to be excitatory, the small fibers inhibitory.

These conclusions are not inconsistent with the observations of Forbes, Davis and Lambert.[1]

[1] Forbes, Davis and Lambert, *Am. J. Physiol.*, 1930, **95**, 142.