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Allocation of Function to Specific Fiber Types in Peripheral Nerves.

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In a recent communication (Heinbecker, Bishop and O'Leary[1]) the fibers in a skin nerve associated with the sensations of touch and of pricking pain were identified. Knowing that the fibers responsible for such pain are included in a well-defined group of small myelinated ones, and that those for touch fall in a different group of larger fibers, we have two points of reference for locating other functions. The differential susceptibility of nerve fibers to novocaine permits a further assignment of various functions mediated by nerves, to known fiber groups. Such fiber groups can be recognized by their potentials when stimulated, and in novocaine anesthesia the differential blocking of these potentials can be correlated with the differential disappearance of sensations.

Observations were made on 3 surgical patients to determine the order of disappearance and reappearance of various sensations and of skin temperature changes during low spinal anesthesia produced by dissolving novocaine crystals in spinal fluid. The changes noted were first a very early increase in skin temperature, after 2 to 3 minutes a loss of sensitivity to heat and cold, and then to cutaneous and pressure pains. The order of disappearance of these sensations was definitely distinct but the time interval between their disappearance was brief. After a distinctly wider gap there occurred a loss of motor function and after another short interval a loss of joint sense, sensation of pressure and touch. In recovery the order of sensibility return was reversed with the gaps between the return of different sensations much wider.

In vitro experiments to determine the effect of novocaine on the action potential of the cat's saphenous nerve definitely showed that the first potential to disappear was that derived from unmyelinated fibers. Then the potential derived from the small somatic myelinated fibers and finally the potential derived from the large thickly myelinated fibers of this nerve were eliminated.

A correlation of the experimental data now permits an allocation of specific functions to specific fibers in a skin nerve. The first

[1] Bishop, George H., Heinbecker, Peter, and O'Leary, James, PROC. SOC. EXP. BIOL. AND MED., 1932, **29**, 928.

fiber type to be rendered functionless is undoubtedly the unmyelinated. Bishop and Heinbecker[2] have shown that such fibers in sympathetic nerves are responsible for vaso constriction. The saphenous nerve has a sympathetic component composed of non-myelinated fibers some of which undoubtedly have such a function in addition to the unmyelinated fibers of the dorsal root whose stimulation causes vaso dilatation.

Fibers conveying the impulses aroused by painful pricks were shown previously to be the smaller relatively thinly myelinated ones found in a skin nerve. Fibers whose activity results in temperature sensations lose their function under novocaine *just* prior to such 'pain fibers'. Consequently temperature fibers are considered to be the smallest thinly myelinated fibers of the somatic type to be found in a skin nerve. It is consistent with our results to explain the fact that on electrical stimulation of a skin nerve a person fails to obtain any recognizable sensations of heat and cold as being due to the slightly smaller size of the temperature fibers since the somewhat larger 'pain' fibers would be stimulated at lower threshold, the pain so caused masking temperature sensations requiring a still stronger nerve stimulus.

'Touch' fibers have been determined to be large thickly myelinated ones. Joint sense and pressure sense disappear in the development of novocaine anesthesia at approximately the same time as does the sensation of touch. It is concluded, therefore, that the largest myelinated fibers convey the impulses responsible for these sensations.

In the course of these experiments it has become obvious that from the point of view of the nerve fibers involved, the sensation of pain is not simple. Pain can result from the effect of specific fibers activated by end organs excited by pricking and by pressure. Discomfort comparable in degree but qualitatively distinguishable from such pain can also result when the sufficient number of fibers of other types such as those responsible for heat and cold are sufficiently stimulated but probably not normally from stimulation of touch and pressure fibers. This phase of the subject will be more completely developed in our final report.

[2] Bishop, George H., and Heinbecker, Peter, *Am. J. Physiol.*, 1932, **100**, 519.