

80. *The General Idea of the Theory of Decrementless Conduction.*

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It is a well known fact that the nervous impulse propagates without decrement in its intensity and velocity in the normal fresh nerve to which the all or none principle is valid. On the other hand, in the narcotised region of nerve, the decrement theory has been generally accepted. According to this theory,

1. The intensity of nervous impulse suffers decrement during passage along the narcotised region of nerve, that is, as it will be seen in Fig. 1, the size of the nervous impulse becomes progressively less as it passes through the narcotised stretch of nerve.

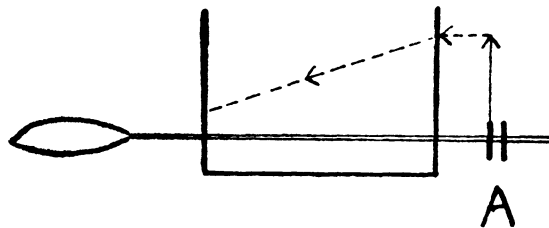


Fig. 1.

2. The rate of nervous conduction suffers decrement during passage along the narcotised region.

3. The all or none principle is not valid ; in other words, in the narcotised nerve the size of the nervous impulse is dependent on the strength of stimulus applied—heterobol in the sense of Verworn.

This decrement theory is the basis upon which the modern physiology of nerve and muscle has been based.

From critical review of the experiments from which the decrement theory above mentioned is derived, and at the same time from the nature of the nervous excitation and its conduction, I came to doubt the decrement theory. With twenty members in my laboratory the problem

was investigated from various aspects, and based on experimental results, I have formulated a new theory, which is called the theory of decrementless conduction. This new theory was first reported at the Second General Meeting of the Japanese Physiological Society in April 1923, and in March, 1924, I published a monograph entitled "the theory of decrementless conduction in narcotised region of nerve". The second monograph entitled "the further studies on decrementless conduction" appeared in February, 1926. Various experimental results upon which the new theory is based, and the detailed criticisms of the old theory of decrement are presented in them. The main conclusions of the experimental results described in both monographs will be briefly enumerated.

1. The *intensity* of nervous impulse does not suffer decrement during passage along the narcotised region of nerve. Fig. 2 in a diagram explains the conduction of nervous impulse in narcotised region. It suffers reduction as soon as it enters the narcotised region, but propagates with constant intensity.

2. The *rate* of the nervous conduction suffers no decrement during passage along narcotised region. Fig. 2 may serve as a diagram showing the rate of conduction in narcotised region, if we consider that the ordinates express the rate of conduction.

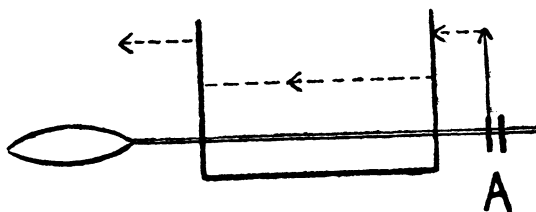


Fig. 2.

3. The nervous impulse of *subnormal* intensity (for instance the impulse evoked in the relatively refractory period) suffers no decrement during conduction along the narcotised region of nerve.

4. The nervous impulses of *varying intensities* are extinguished at the same stage of narcosis, that is the intensity of nervous impulse has no influence at all on its ability to travel through the narcotised nerve. Consequently the size of nervous impulse can not be measured in terms of its ability to travel through the narcotised region of nerve.

5. The *all or none principle* is valid in narcotised region of nerve. It must be noted that the quantity of "all" (the size of the maximal

response) becomes gradually less as narcosis deepens, but at any stage of narcosis the size of nervous impulse is not dependent on the strength of stimulus applied ; it gives always the maximal response possible in the stage of narcosis at the moment, or none at all.

6. The nerve loses by narcotisation its excitability and conductivity at the *same* time. At the very moment at which the conduction fails from the outside electrode A (Fig. 2) the narcotised region loses its excitability completely ; in other words, after the stage of narcosis at which the impulse starting from the outside electrode fails to reach the muscle the nerve within the narcotising chamber is not excitable at all. The reason why the *strong electric* stimulus is successful to provoke muscle contraction, being applied within the narcotising chamber, after the conduction failed from the outside electrode is due to the spreading of the stimulating current.

Thus, according to the new theory of decrementless conduction, the nerve suffers *no qualitative* but only quantitative change by narcotisation, whereas the old theory of decrement maintains that not only narcosis but also any other abnormal condition of nerve bring about qualitative change (decrement and inapplicability of all or none law)

Alexander Forbes and his collaborators made some experiments on the same problem and reported in March of 1925 that they obtained precisely the same result as we, and concluded that there is no decrement during conduction through narcotised region. Furthermore we succeeded in finding the sources of error which had led to the inference of conduction with decrement, (1) the diffusion of the narcotic near the edge of the narcotising chamber, (2) the effect due to the spread of the stimulating current.
