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LOCOMOTOR FUNCTIONS

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The articles summarized in this review fall rather definitely under three headings: the energy relations of functioning muscles, physiological experiments on the locomotor reflexes and pathological observations on disturbed locomotion. Benedikt (1), in addition to describing a case of paralysis of the muscles supplied by the peroneus and the tibialis nerves, applies Watt's formula to the performance of any muscle. According to this formula, the efficiency of a muscle is represented by mht , the product of the muscle force, m , into the distance, h , through which the muscle acts, and t , the duration of the action. The energy transformations of man upon a horizontal path are calculated by Brezina and Reichel (2), from experimental data determined by Brezina and Kalmer in 1911. The problem of the relation of the size of the animal body to the velocity of locomotion is attacked by DuBois Reymond (4) on the basis of experimental observations made by O. Fischer. DuBois Reymond questions the conclusions of Fischer that the law of corresponding velocities applies to human beings as well as to inanimate self-propelling objects such as ships. The law is stated as follows: if the resistance of the water to a ship of the size, l , with a velocity, v , is equal to r , then the resistance of a ship of the size, nl , with a velocity $v\sqrt{n}$ is equal to n^3r^2 , i. e., is proportional to the cubic contents. It has been supposed that the same law holds for human locomotion. Therefore with equal muscular effort, the velocity of larger and smaller men would be proportional to the square root of the length of the body, i. e.,

$$\frac{v_1}{v_2} = \frac{\sqrt{l_1}}{\sqrt{l_2}}.$$

O. Fischer made observations on 103 soldiers and 8 students. These subjects walked at "*Wanderschritt*" a distance of 2 kilometers. The length of body, length of step, length of leg, number of steps and velocity were determined. Using this data, DuBois Reymond attempts to determine the applicability of the law of corresponding velocities to human locomotion. He divides the 111 subjects of Fischer into nine groups according to the length of the body. With these figures he correlates the velocity of travel. Reducing the results to percentages, he finds that the small individuals have a somewhat greater speed of movement than the larger individuals. The average height of the two larger groups was 172.1 cm., that of the two smaller groups 160 cm. The ratio of the roots of these numbers is 1,000 : 962, while the ratio of the velocities of the two groups is 1,003 : 1,002. DuBois Reymond concludes that the law does not hold for human locomotion. The absolute force of a muscle is measured by the greatest weight which a muscle can just raise. Reys (9) has attempted to calculate that quantity for the human triceps suræ. First estimating the volume of the muscle, he obtains the value of 566 kilograms as the absolute force of this muscle in a strong, healthy, man. The same unit for each square centimeter of cross section of the calf muscle is 5.2 kg. The effect of high altitudes on muscular work was studied by Vallot and Bayeux (10) by recording the number of revolutions of a squirrel cage at a low level and again in the mountains. Three squirrels were used at Chamonix and at Mont Blanc. The average number of turns of the cage at Chamonix was 6,700 per day. At Mont Blanc the average number of turns was 924 and, after two weeks at Chamonix, was 7,435 per day. Regnault (8) distinguishes three forms of locomotion in man, viz., walking, gymnastic exercise and running. Walking is most advantageous in slow locomotion. According to the results of Marey and Demy, the optimum rate of step is 60 to 65 per minute. This gives a man of 167 cm., making a step of 140 cm., a distance of 5,040 to 5,460 meters per hour. Above that from 65 to 75 steps per minute the work increases very rapidly and is disproportionate to the result. For more rapid locomotion the author distinguishes *la marche en extension* from *la marche en flexion*. Ponzo (7) records a curious illusion of size which depends upon a change in volume of the fingers caused by the pulse. Objects held between the fingers seem to enlarge and contract with the pulsations of the heart. The movement is attributed to the object and not to the fingers. The author describes an experiment in which, with a

card 25 by 15 cm., the apparent movement can be reproduced. The experiment is classified as an objectification of movement which is a result of the law of the excentric projection of sensations. The relation of the production of heat in a muscle to the time of appearance of the contraction has been studied by Herlitzka (6) by means of a suitable recording apparatus and a thermoelectric pile for determining the presence of a change in temperature. He found that there was a considerable difference in time between the contraction latent period and the thermic latent period; the former was always the shorter. The author holds that the liberation of heat is to be considered an effect and not the cause of the contraction. Adrenin exerts a powerful influence upon smooth muscle fiber. Its effect upon striated muscle has been a matter of doubt. Yas Kuno (11) working with sartorius muscle, with a solution of the drug of 1 : 16,666, found that there was no physiological effect. Application of the adrenin to the rami communicantes in the caudal region of the cord produced no change in the tonus of the legs. In the decerebrate animal, Sherrington demonstrated a plastic extensor tone. T. G. Brown (3) observed a condition of plastic flexor tone in monkeys both after decerebration and chemical narcosis. The author suggests that the phenomenon may be due to the action of the nucleus ruber, for the reason that he observed a similar condition after excitation of that center. It has long been known that locomotion which has been lost as a result of disease of the central nervous system may be regained in certain cases by appropriate exercises. Gordon (5) describes, from the point of view of the clinical neurologist, the nature of the exercises which are beneficial in diseases of the nervous system.

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REACTION TIME

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Woodrow (3) proposes to measure attention by efficiency in simple reaction. Unfavorable preparatory intervals and weak intensities of stimuli were used as detractors, the latter for securing different degrees of attention, and the former to serve as detractors with each of these degrees. When the preparatory intervals of 1, 2, 4, 8, 12, 16, 20, 24 seconds were presented in a regular order, there was a gradual increase in the reaction times expressed as a law that the reaction time equals a constant plus the product of the logarithm of the interval and a constant. When the intervals were presented irregularly there was little difference in the reaction times, all being much lengthened. The prolongation of the times is due solely to the fact that attention is not maximally adjusted. This gives the basis for a satisfactory method of detractor. Different degrees of attention were secured by using four widely different intensities of light and the detractor effect of unfavorable preparatory intervals on each intensity was determined. The results are formulated in the law for any preparatory interval of 2 seconds or over: "The absolute increase in reaction time produced by the use of unfavorable intervals as detractors varies inversely as the degree of attention detracted from." Choice reaction times are influenced fully as much by irregularity in the preparatory intervals as are simple reaction times and the same law of detractor holds for both. Experiments on the effects of practice seem to show that contrary to common view the degree of attention does not improve with practice.

Williams (2) studied the correlations between reaction time,