15.

ON THE PHYSIOLOGICAL BASIS OF PHYSICAL EDUCATION.

AN ADDRESS TO INSPECTORS OF SCHOOLS AT THE SOUTH-WESTERN POLYTECHNIC, CHELSEA, ON APRIL 25, 1905.

By Invitation of Colonel G. MALCOLM FOX.

By Sir LAUDER BRUNTON, M.D., D.Sc., LL.D. Edin., LL.D. Aber., F.R.C.P., F.R.S.

Consulting Physician to St. Bartholomew's Hospital.

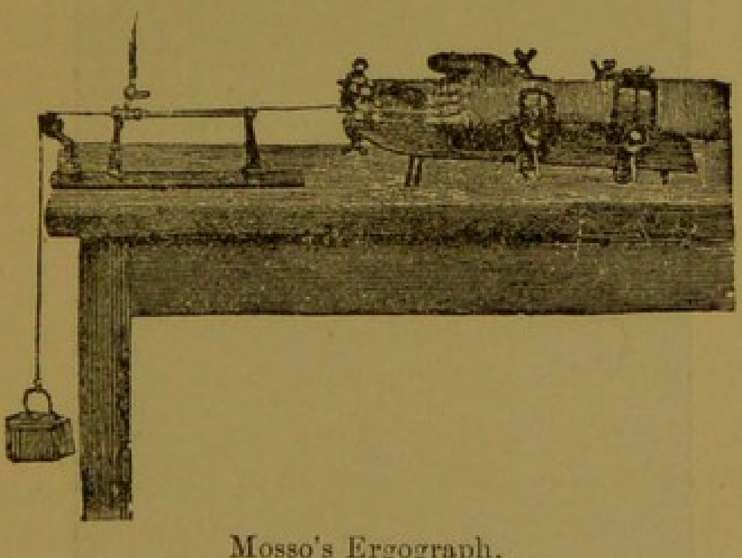
GENTLEMEN,—It is probable that at one time or another every one of you has seen on the sea beach after a storm a number of shapeless and useless masses of dirty jelly, disgusting to look at and still more so to tread upon. Yet those shapeless masses when floating in sea-water were delicately tinted, shapely, and graceful organisms. But they were only capable of retaining their beauty under certain very favourable conditions, and when thrown out of the water they had no power of preserving their shape. If you could overcome your disgust sufficiently to lift one of them up and put it in a pot, it would take the shape of the pot, whatever that might be. I think it is a prison chaplain, the Rev. Mr. Horsley, who has said that there are moral as well as physical jellyfish, men and women who would be very good if their environment were such as to make them good, and bad if their environment were bad. They are perfectly well behaved in prison, but it is absolutely hopeless to reclaim them and they lapse at once into their usual criminal ways on being released. Others, again, are more difficult to deal with, not so amenable to good influences, but if they are improved the improvement remains permanent. The first are moral jellyfishes, the latter are moral vertebrates. Without a backbone, physical or moral, no creatures can ever rise high in the scale of existence, and to develop backbone, moral as well as physical, is one of the great objects of Education.

In the process of evolution it would seem as if some creatures had tried to gain strength by putting a rigid skeleton outside them, but this does not allow of expansion. Crabs may shed their shell from time to time and grow to a considerable size, and ants may evince a great amount of intelligence, but all creatures with an external shell are limited in their growth, both bodily and mentally. The highest members of the mollusc tribe, the cuttle fish, have got what we may term a backbone, but it has no joints, and they remain far down in the scale. In order to rise, we require a skeleton which shall not only be internal but capable of flexion and extension, and this we find in the vertebrates. In the backbone which supports the trunk a certain amount of movement in all directions is required, combined with great strength, and this is attained by its being composed of numerous bones firmly tied together by ligaments and acted upon by powerful muscles. The movement between any two of them is slight, yet the movement of the whole series is considerable. In the extremities we require freer movements, and this is attained by having long bones. In the arms and thighs there is a single bone, but in the forearms and legs, which support the feet and hands, a rotatory movement is required, combined with stiffness, and this is attained by having two bones, one of which moves rigidly whilst the other can rotate. In the hands and feet we again find numerous small bones to allow of free movement combined with strength. These bones are moved upon one another by muscles which have the power of contracting and relaxing. It is evident that in the struggle for existence rapidity of action is of great importance, and if three or four boys were all picking at once from the same blackberry bush, it is evident that the one who could move his hand quickest from the bush to his mouth would get the most blackberries. Such an action as this is obtained in the body by having muscles which pass over more than one joint. To take, for example, that well-known muscle, the biceps. We find that it passes over both the shoulder and elbow joint, and that it is inserted into one of the bones of the arm—the radius—in such a way that it tends to turn the palm of the hand upwards, so that, supposing a boy to have got a blackberry, the biceps tends to bring his hand into the right position to go to the mouth, to bend the hand on the forearm, and the forearm on the body, the very movements that are required to bring the blackberry quickly to his mouth. It is astonishing to find how many muscles are combined in the simplest movement. Get someone to hold your forefinger or middle finger stiffly extended and try to bend it against the resistance which he affords. At the same time put your hand upon your own arm and you will feel that not only the muscles of the forearm but the biceps and even the muscles of the front of the chest are all contracting in order to bring about flexion of the finger. The same thing occurs all over the body, and in the act of standing, a great number of muscles indeed are involved, many of which pass over two or more joints. Their contraction is co-ordinated by the nerve centres in the spinal cord, the ganglia at the base of the brain and the brain itself. Some acts occur without our consciousness and with great rapidity. For example, when anything touches the eye or even comes near it, the eyelids shut for the purpose of defence, and this occurs very quickly indeed. The nervous mechanism by which some simple actions necessary to life are performed appear to be present at birth, and a child when put to the breast will immediately begin to suck. Among birds, complex movements like running and pecking are performed as soon as the chick emerges from the egg. But in man, complex actions such as those of walking and speaking are acquired slowly and with difficulty. The impulses which pass from the organs of sense, such as the eye or ear, appear to go to the higher centres in the brain, and from these to be reflected down to the basal ganglia, and thence to the muscles. At first the nerve messages act slowly and imperfectly, so that the right muscles are not put into action. The child totters and stumbles when it tries to walk, and cannot articulate its words aright. Slowly the motor centres become trained and by and by the nerve channels become, as we may term it, short-circuited, so that an impulse starting from the organs of sense will produce the proper muscular response, not only without conscious thought but much more quickly than if the movements were made voluntarily. It is in the nerve centres that time is lost between the application of a stimulus and the proper muscular response. Thus about 18/100 of a second are required for simple reaction, 24/100 for discrimination, and 36/100 for decision. These numbers vary very much with the individual and the condition he is in. The time required, especially for decision, may be greatly lessened by constant practice, until at length the motions, which were at first very slow, very deliberate, and performed with difficulty, become easy, unconscious, and rapid, the proper action following the stimulus without the loss of a single instant. We notice how slowly short circuiting, as I have termed it, of brain paths occurs in children learning to walk or learning to speak, or in grown-up people trying to play a musical instrument, and this fact shows us that physical exercises, even of a simple character, are not at first, by any means, simply bodily exercises. They are mental exercises as well, and learning them is a considerable strain upon the brain as well as upon the muscles. By and by, as they become more familiar, the mental strain becomes less and less, until they are done automatically without any mental exertion whatever.

Now throughout the body, wherever we have a set of muscles, we have also another set possessing an opposing action. If I stand before you with my arms hanging by my side you cannot tell whether they are simply hanging loose or whether I am exerting in them all the muscular force of which I am capable, by putting at the same time the extensors and flexors on the stretch. If I do this the limbs remain motionless but the muscles are contracting powerfully and will soon become exhausted. It is obvious that for rapid muscular movement it is important that as one set of muscles contracts, the opposing muscles should relax, and Professor Sherrington has shown that the same nervous stimulus which causes contraction of one group of muscles produces also relaxation of the opponents. To this power of relaxing muscles or stopping movements the term of inhibition is usually applied and upon the power of keeping the muscles perfectly lax great stress has been laid both by Mr. Eustace Miles in this country and by the professors of ju-jitsu in Japan. When the contractile power of muscles is unduly developed it would appear that their power of relaxing becomes diminished and thus they become unfitted for rapid movements, although they may be able to exert enormous power at a slow rate. If you will compare the statues of the Farnese Hercules and of the Apollo Belvedere or the Borghese athlete, you will readily understand what I mean, and it seems to me that what we wish to develop in the rising generation is not the heavy muscle-bound frame of the Hercules but the light, strong and yet pliant and active physique of the Apollo. Fancy Hercules trying to play the favourite games of England; he might be very formidable in the football field, but he would be completely useless at cricket, whilst Apollo would be a good man all round.

Now all exertion is followed after a while by fatigue, and this fatigue is of two kinds, (*a*) muscular and (*b*) nervous, and the nervous fatigue usually comes first. A child learning to write becomes tired long before the muscles of its fingers are really wearied and the same is the case with all movements until they have been thoroughly learned. Exhaustion of the muscles themselves, however, can bring on fatigue even when the nerve centres are not concerned at all, and this fatigue will increase until at length the muscles will not respond at all. This has been worked out very fully by my friend, Professor A. Mosso, by means of an instrument which he calls his ergograph (Fig. 1). This consists practically of a weight

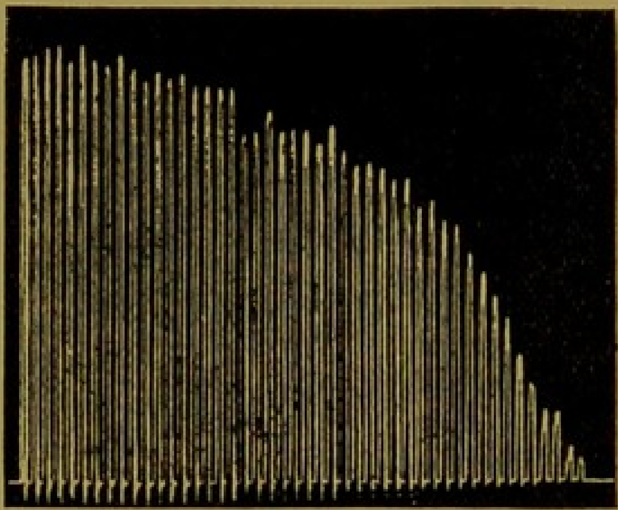
FIG. 1.



Mosso's Ergograph.

suspended from a cord which runs over a pulley. The weight is drawn up by the rapid contraction of a finger and each contraction is recorded upon a revolving cylinder. The amount of contraction is shown by the height of the curve traced, and it is found that after a while the contractions become less and less until they cease altogether. The curves (Fig. 2) show

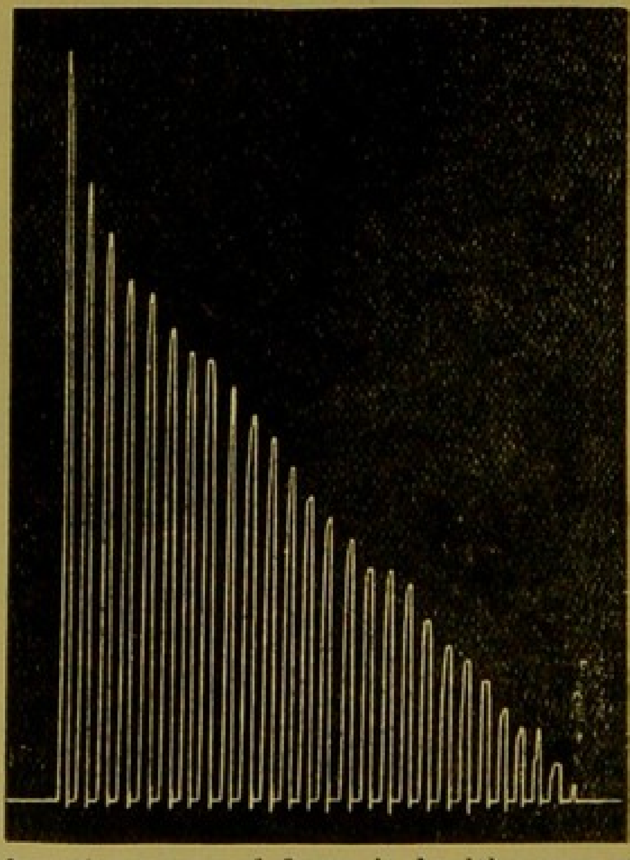
Fig. 2.



After Mosso. Exhaustion curve of finger in healthy man from voluntary movement.

exhaustion of the finger in a healthy man from voluntary movement. Fig. 3 shows exhaustion where the muscles were

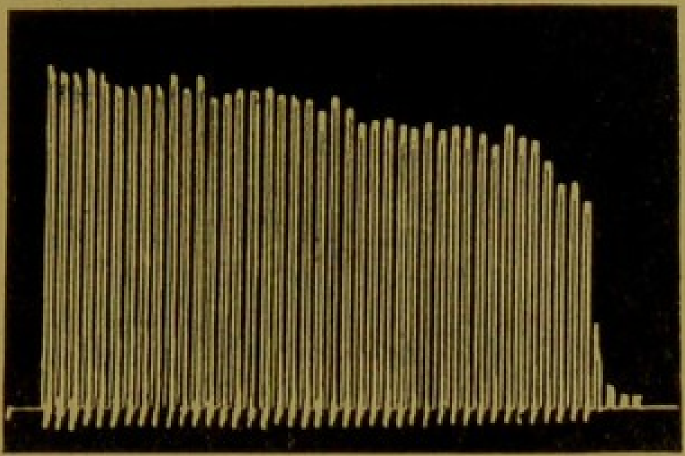
Fig. 3.



After Mosso. Exhaustion curve of finger in healthy man where the muscles are caused to contract by electrical stimulation.

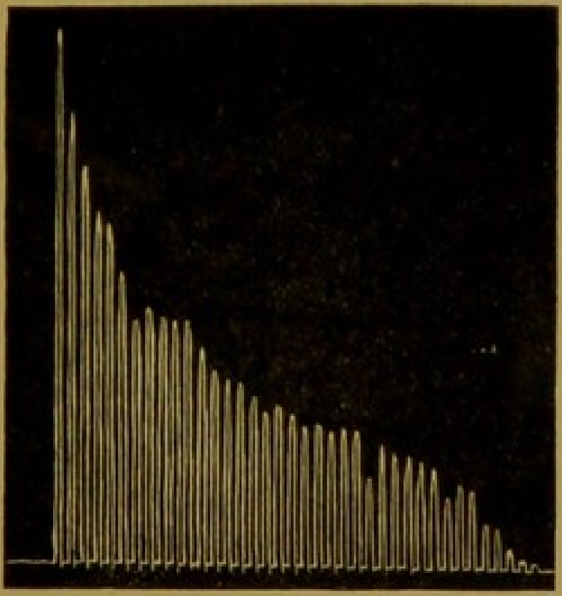
caused to contract by electrical stimulation. In some persons the power of will appears to make the muscles contract for a length of time almost up to their maximum and then they stop suddenly (Fig. 4), while in others the failure is gradual (Fig. 5).

FIG. 4.



After Mosso. Tracing from Dr. Patrizi, showing long-continued movement and abrupt failure.

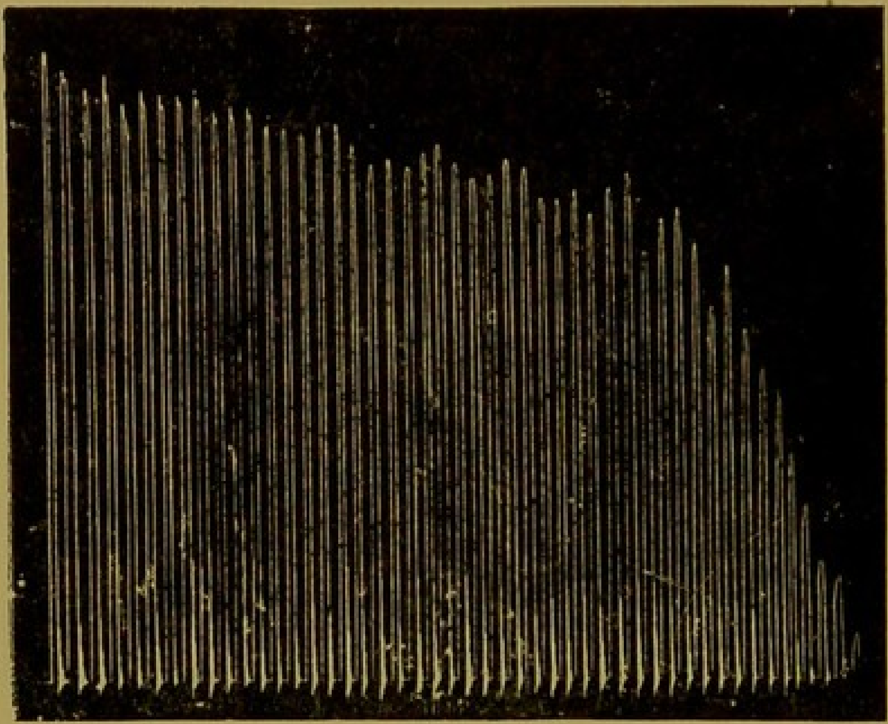
FIG. 5.



After Mosso. Tracing from Dr. Maggiora, showing rapid but gradual failure from fatigue.

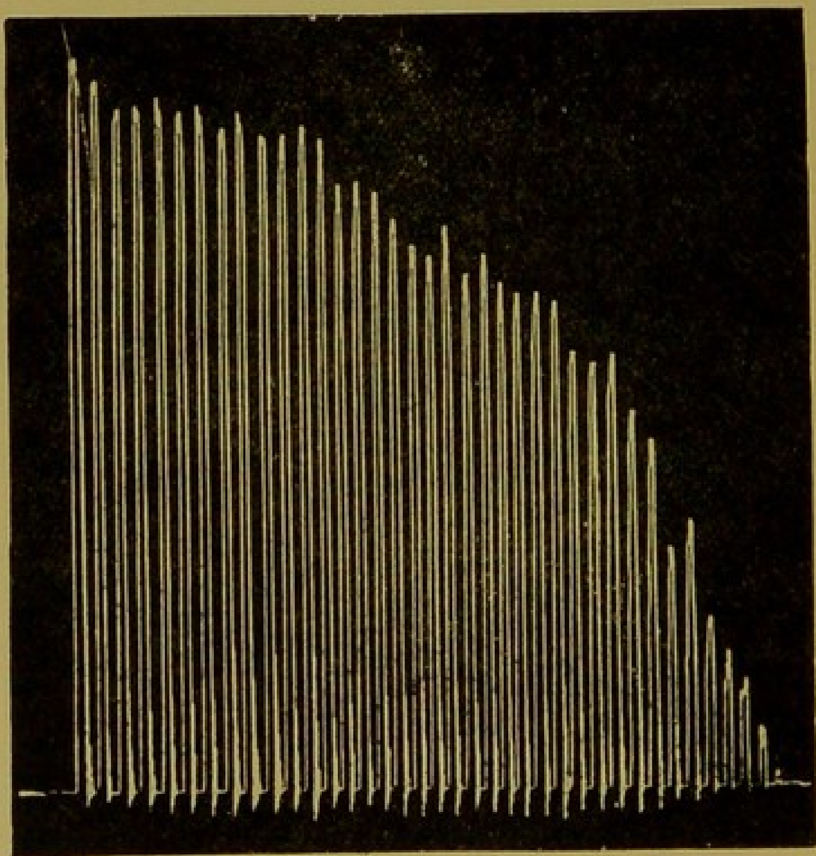
Now mental work also causes muscular fatigue. Fig. 6 shows a normal tracing, and in Fig. 7 you will notice that the contraction of the finger in the same man ceases much more quickly when he was fatigued by giving a lecture. In the first part of Fig. 8 the tracing is normal, whilst the second

Fig. 6.



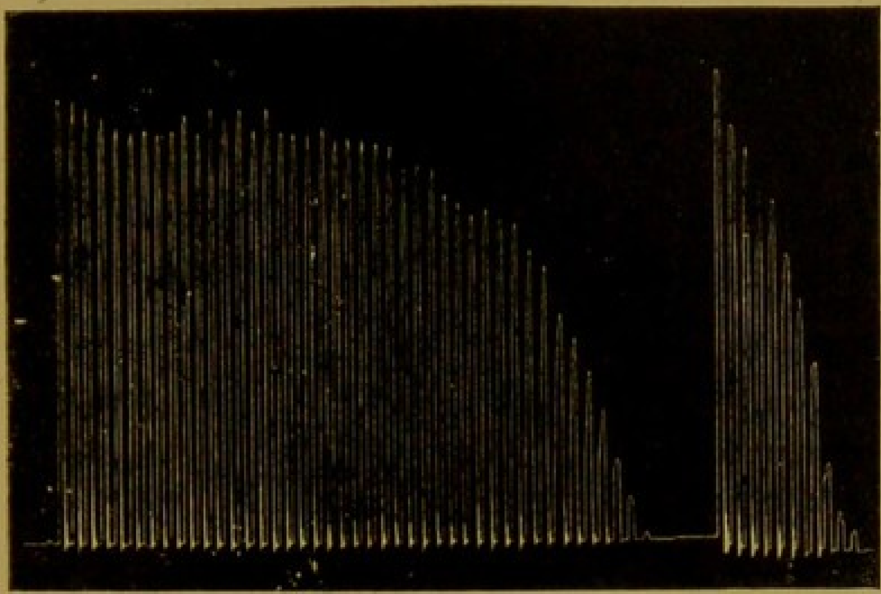
After Mosso. Normal tracing from Dr. Maggiora.

Fig. 7.



After Mosso. Tracing from Dr. Maggiora, when fatigued by giving a lecture.

FIG. 8.

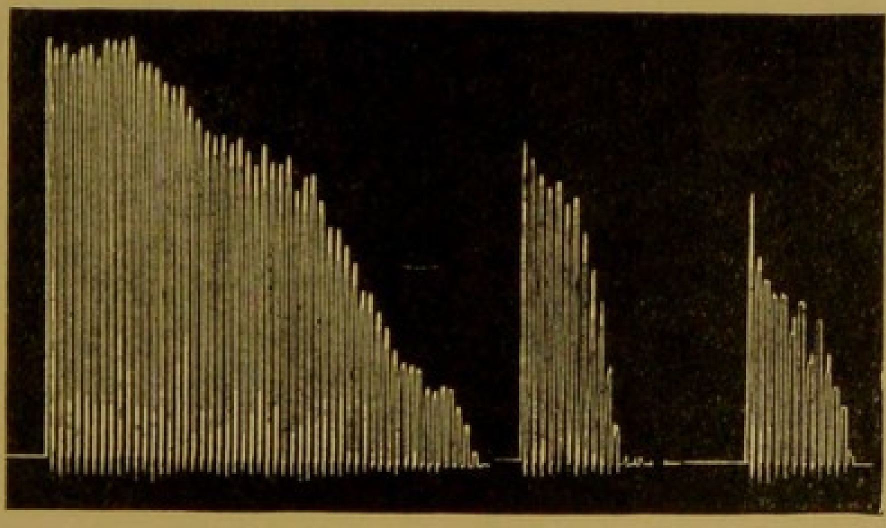


A B

After Mosso. Voluntary contraction. A, Before conducting an examination. B, After examining nineteen candidates.

part, where exhaustion comes on exceedingly rapidly, was taken from the same professor after examining a number of candidates. In this figure the contractions were voluntary and one might, therefore, suppose that the brain was exhausted and not the muscles, but the next figure (Fig. 9) shows that brain work will

FIG. 9.



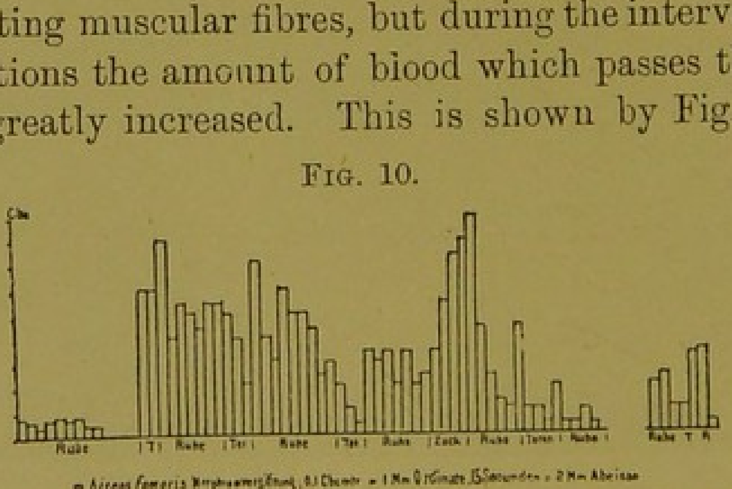
A B C

After Mosso. Exhaustion curve from electrical stimulation. A, before examination. B, Immediately after examination. C, Two hours after close of examination.

bring on muscular fatigue, that is to say will bring on changes in the muscles themselves which lessen their contractile power, for the curves shown in it were obtained by electrical stimulation of the muscles of the finger in which the nervous system took no part. Yet the first part of the curve shows normal endurance, whilst rapid exhaustion occurred in the second, which was taken immediately after examining candidates and the third, which was taken two hours after the close of the examination, shows even more exhaustion of the muscle as the contractions are lower.

There are three ways in which a fire can be put out. First by failing to supply it with fuel; secondly, by smothering it in ashes; and thirdly, by both combined. The way to keep a good fire is to put on plenty of fuel, and to apply the poker so as freely to remove the ash. The same is the case with muscle. Exhaustion in it depends partly upon want of fresh material, but to a much greater extent on the accumulation of what may be called muscular ash. Fresh material is brought and waste products are removed by the blood which circulates through the muscle, and nature has made provision for keeping up exertion by causing the vessels in the muscle to dilate when the muscle is active, so that much more blood flows through it than when it is at rest. It was shown by Ludwig and Sadler that during actual contraction the flow of blood through the muscle may be lessened by the compression of its blood vessels by the contracting muscular fibres, but during the interval between the contractions the amount of blood which passes through the vessels is greatly increased. This is shown by Fig. 10, where

Fig. 10.



After Ludwig and Sadler. The marks along the base lines indicate seconds; the height above the base line indicates the amount of blood flowing from the veins of the biceps of a dog during tetanus (T or tet), during rest (Ruhe), or during simple contraction (Zuck).

the height above the base line indicates the quantity of blood passing through the blood vessels of a muscle in five seconds.

But the muscle is not nourished directly by the blood in the vessels. The muscular fibres take their food and pour out their waste into the muscle-juice or lymph which bathes them, and each muscular contraction tends to renew this. For the muscles are surrounded by a strong fibrous sheath or fascia, and between this and the muscle is a space in which this lymph is present (Fig. 11). When the muscle contracts it squeezes the lymph

FIG. 11.

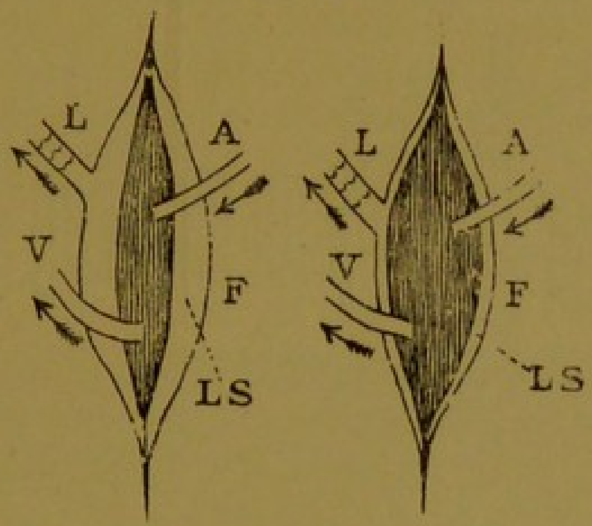


Diagram of longitudinal sections of muscles, I in relaxation and II in contraction. F is the fibrous fascia or sheath of the muscle. L S a lymph space between the muscle and the outer layer of fascia. L is a lymphatic vessel with numerous valves, by which the lymph containing waste products is removed. A is an artery by which fresh blood is brought to the muscle; and V is a vein by which blood is removed from it. Each time the muscle contracts, as in II, it lessens the size of the lymph space and drives the lymph onward through the lymphatics. Each time it relaxes it tends to create a vacuum within the fascia, and thus lymph is sucked out of the muscle into the lymph space, while fresh arterial blood rushes into the muscle.

out, and when it relaxes it tends to cause a vacuum in the sheath, and thus draws the lymph out of the muscle into the space. From this it is again ejected by the next contraction into the lymphatic vessels, and its return is prevented by the numerous valves with which they are furnished. In this way we have a regular pumping action, each contraction of the muscle driving the blood and lymph onward, and each relaxation drawing blood and lymph into it. This can be imitated artificially by massage—kneading the muscles—and this process restores contractility to the muscles after they have been exhausted. The effect of massage upon the flow of blood through the muscles is extraordinary, for Dr. Tunnicliffe and I have found that the rate of flow through the blood vessels was increased threefold by massage (Fig. 12). The extent to which

Fig. 12.

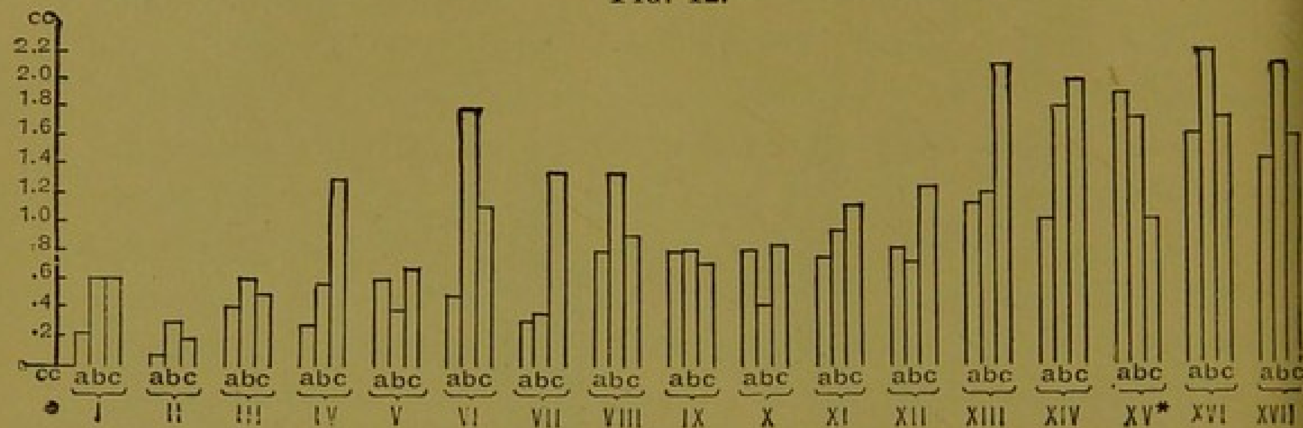
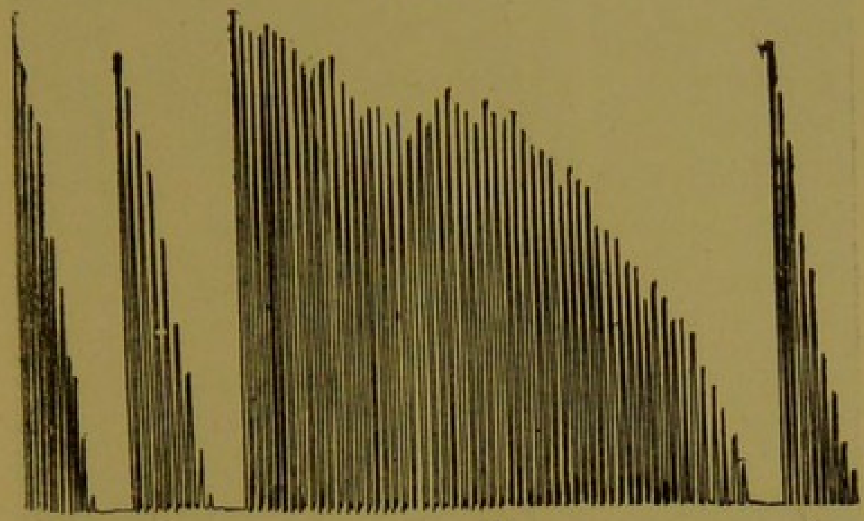


Diagram to show the effect of massage on the flow of blood through muscle; a, shows the amount of blood in cubic centimetres which flowed from a muscular vein when it was simply opened; b, during massage; c, after massage.

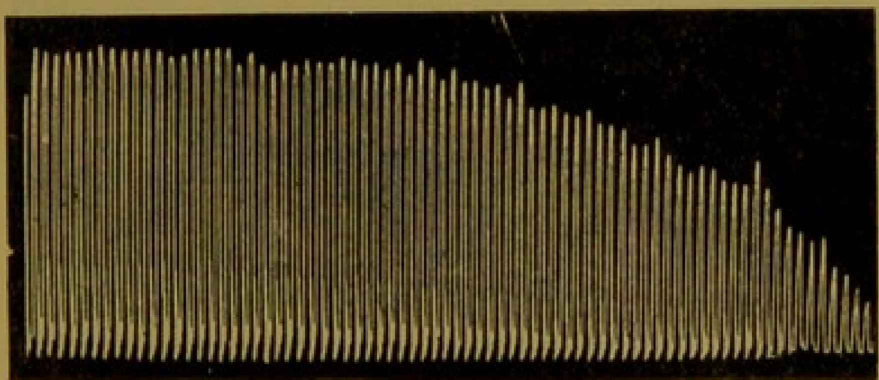
massage increases the contractility of muscles after they have been fatigued is shown by Fig. 13. It is not very easy to say what the effect of training upon muscles is, but it is certain that it greatly increases their power of resisting fatigue. This is shown by Fig. 14, which ought to be compared with Figs. 2 and 6. The effect of massage upon the muscles is to raise the blood pressure within the vessels generally, as is shown by Fig. 15, and muscular contraction either reflex or voluntary, has a similar or greater result, and causes the blood to pour more quickly from the vessels into the heart, whilst the heart, in its turn, drives the blood on more quickly through the vessels. Muscular exertion quickens the pulse, and accelerates circulation, but it is not upon the circulation alone that its effect is exerted. Respiratory movements are increased both in depth and rapidity. They not only bring more oxygen into the lungs to aërate the blood, but they have also an effect upon

Fig. 13.



After Maggiora and Vinaj. Blät. f. Klin. : Hydrotherapie, 1892, p. 9. 1. The fatigue curve of the left hand raising a weight of 3 kilogrammes every two seconds. 2. The fatigue curve of the right hand. 3. The fatigue curve of the left hand after five minutes' massage. 4. That of the right hand without massage.

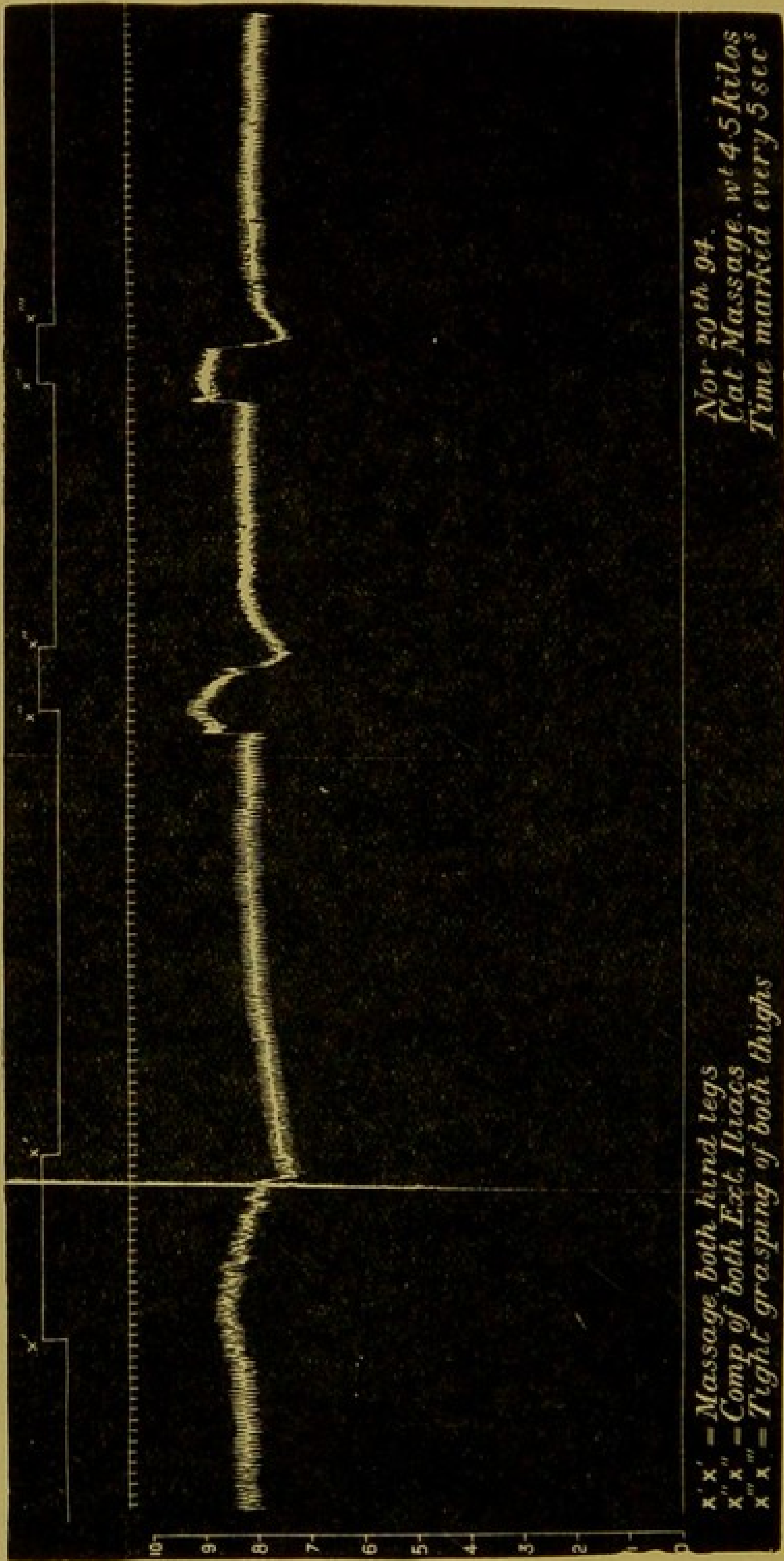
Fig. 14.



After Mosso. Showing the effect of training, in increasing endurance as compared with Fig. 2, from the same person. Owing to a difference in the apparatus the height of the curves is not comparable. The amount of work done was really double that in Fig. 2.

the heart similar to massage upon the muscles. The respiratory movements, especially when deep, help to press the blood out of the heart and to attract blood into it. The movements of the heart itself also tend to carry on a kind of self-massage. These effects were shown by my friend, Professor Kronecker, and will be understood from the accompanying figures. The first of these (Fig. 16) shows the thorax during inspiration and during contraction of the heart. In this condition

Fig. 15.



Tracing showing the effect of massage on blood pressure.

there is a tendency to the formation of a vacuum in the pleura and pericardium, into which the lymph is drawn from the lymphatics, whilst blood is sucked in from the vena cavæ.

FIG. 16.

Diagram of a transverse section of the thorax during inspiration and cardiac systole. It shows the tendency to the formation of a vacuum in the pleural and pericardial cavities.

In Fig. 15 the chest is shown during expiration and cardiac diastole, when the walls of the pleura and pericardium are pressed together and lymph is ejected into the lymphatic vessels.

FIG. 17.

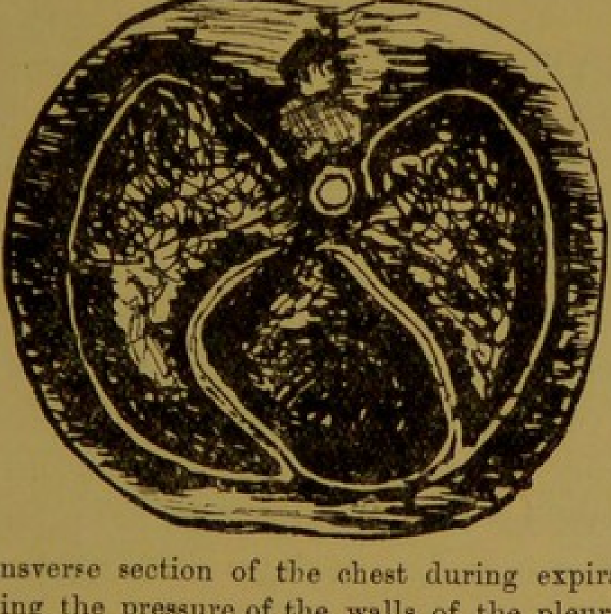
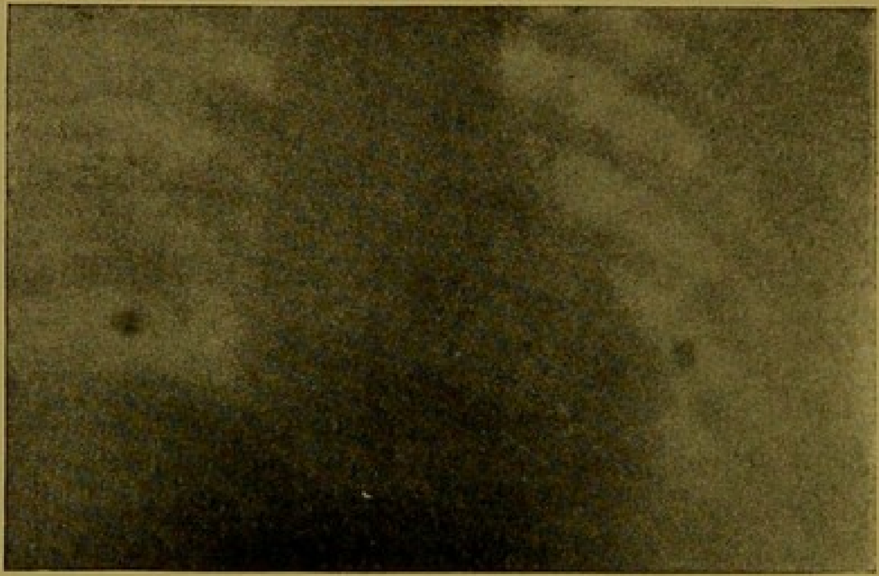


Diagram of a transverse section of the chest during expiration and cardiac diastole, showing the pressure of the walls of the pleural and pericardial cavities against each other.

Exercise within bounds thus tends to increase not only nutrition of the muscles, but of the lungs and heart. But if it is carried to too great an extent the consequences are very different. Cardiac strain tends to cause dilatation of the heart beyond its normal size, and the valves which normally close the orifices and prevent regurgitation of blood become too small and fail to act. The next figure (Fig. 18) shows the photograph of a normal heart taken by the X rays by Professor Schott, of

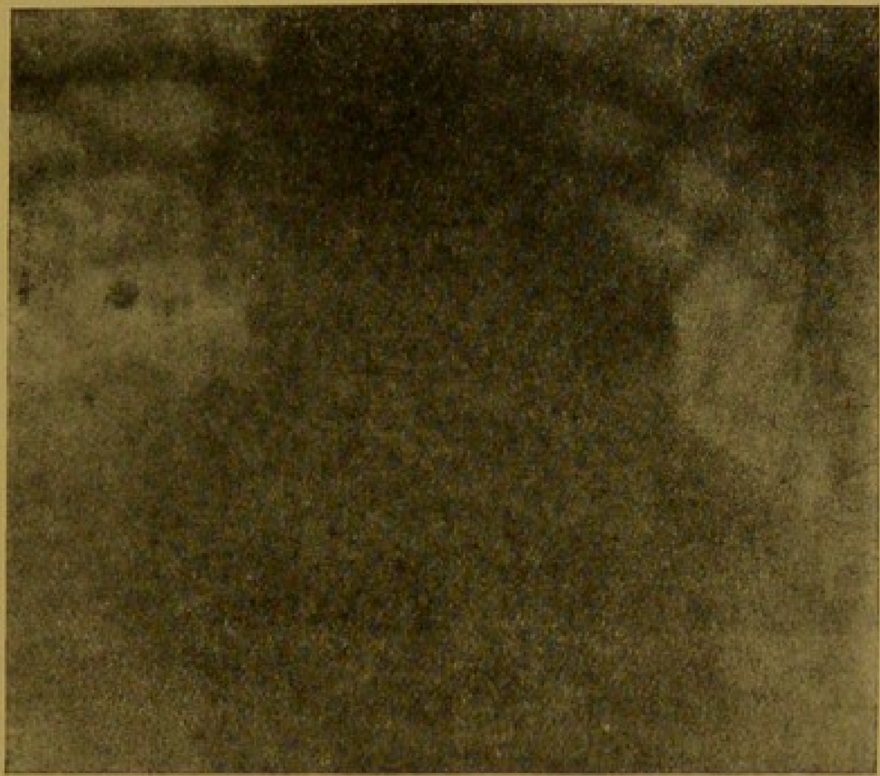
Fig. 18.



After Dr. Th. Scott. Photograph by the Röntgen rays, showing the heart in a healthy man before exertion.

Nauheim, whilst Fig. 19 shows the same heart after very violent exertion and the dilatation which the exertion has produced is quite evident. If the exertion be not very great the heart tends to resume its normal size in a short time, but if it be too long continued the heart becomes permanently strained and dilated. The consequences of this are shown in Figs. 20, 21 and 22, where the two smaller figures show a healthy heart in full contraction, one from the side and the other from above, and the large figure shows a dilated heart in which the valves are incompetent. It is evident that cardiac strain of this sort is to be carefully avoided, but what may be strain for one boy is really insufficient exercise for another and in order to get the best effects of exercise without doing any mischief to the heart, medical examination is absolutely necessary. More especially is care wanted in boys and girls who are growing rapidly because in them the tissues are soft

FIG. 19.



After Dr. Th. Schott. Skiagraph of the heart of the same man as Fig. 18, after violent exertion, showing temporary dilatation.

FIG. 20.

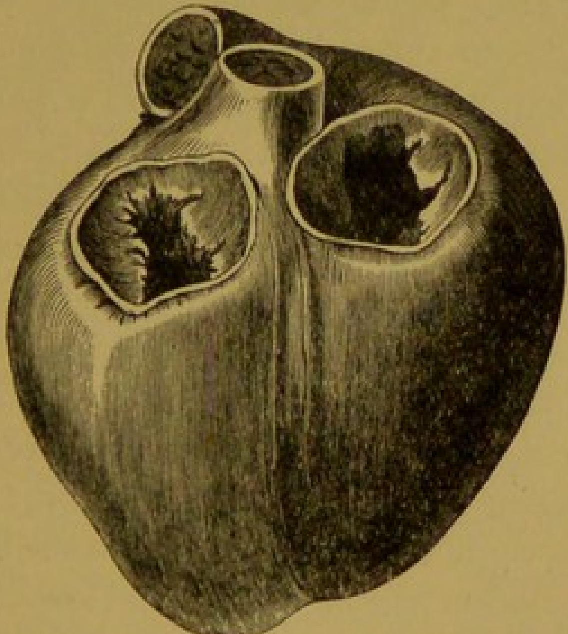


FIG. 21.

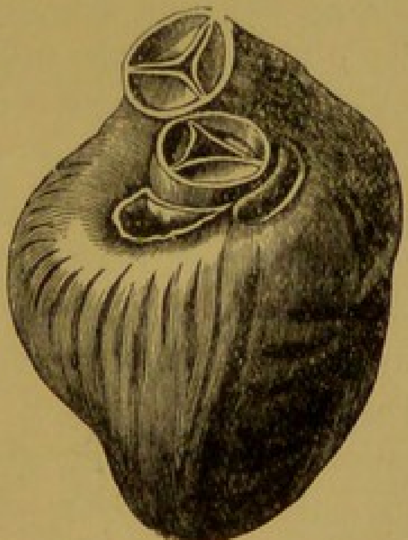


FIG. 20.—Heart fully distended, shewing insufficiency of the valves to close the mitral and tricuspid orifices (seen from the back and the auricles removed, so as to display the auriculo-ventricular orifices).

FIG. 21.—Heart in full systole, showing the mitral and tricuspid orifices so diminished by the muscular contraction that the valves close them easily (seen as in Fig. 20).

FIG. 22.

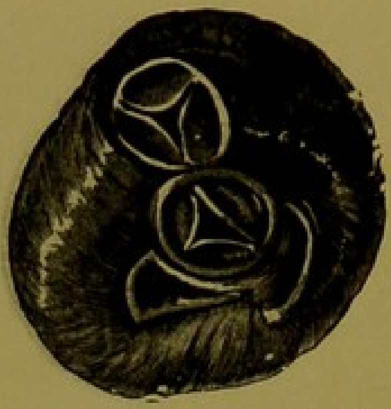


FIG. 22.—The same heart as in Fig. 21, seen from above.

and yield more readily to over strain, and in this relation, too, we must not forget what Mosso has clearly shown, Fig. 8, that mental fatigue produces muscular weakness. If a boy is doing much mental work he is unable for so much physical exertion as he would othewise be.

The converse of this is also true to a certain extent. The brain, like the muscles, requires blood in order to perform its functions and if much blood is going to the muscles less will go to the brain (*cf.* Fig. 23). My beloved teacher, Professor Ludwig, showed that when the vessels of the muscles were dilated, as much blood could pour through them as through all the other channels taken together, and, therefore, if a boy is taking much muscular exercise, we must not expect him to do quite as much brain work. It appears that after the vessels of a muscle become dilated, it takes a little while for them to return to the normal, and when children have been running about playing it takes a little while for them to settle to their work when they come back. But this is not all lost time. During the exertion of playing not only have the vessels of the muscles become dilated but the heart has become stronger in its action, and when, a little while afterwards, the muscles have become quiet and the circulation through them is less, more blood is diverted to the brain, which thus acts more quickly, and more mental work may be done in a quarter of an hour with a good circulation than in an hour with a feeble one. The removal of waste products from the muscles continues for some time after muscular action has ceased, and increased

FIG. 23.

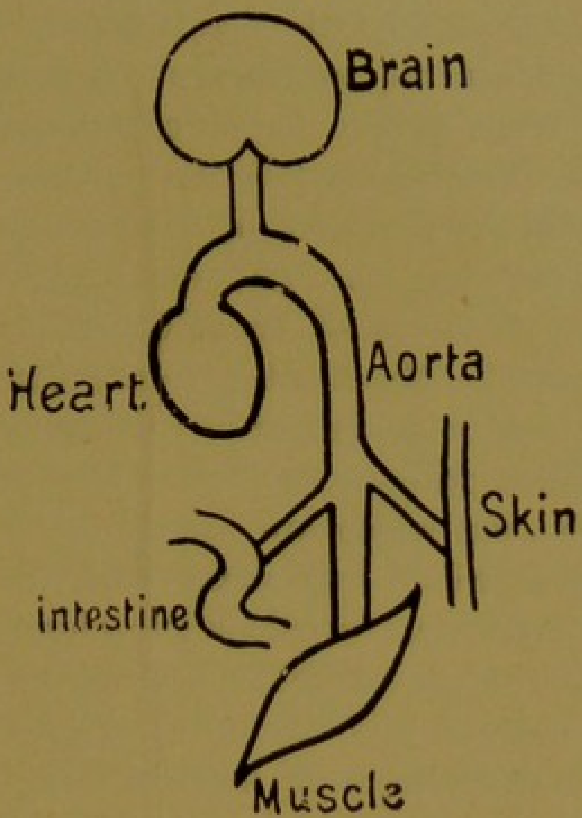


Diagram showing the four great areas for the distribution of blood in the body, viz., the muscles, the brain, the intestine and the skin.

respiration is required in order to burn these waste products completely away. If we run upstairs our hearts will beat quickly and our respiration will be short for some time after we reach the top.

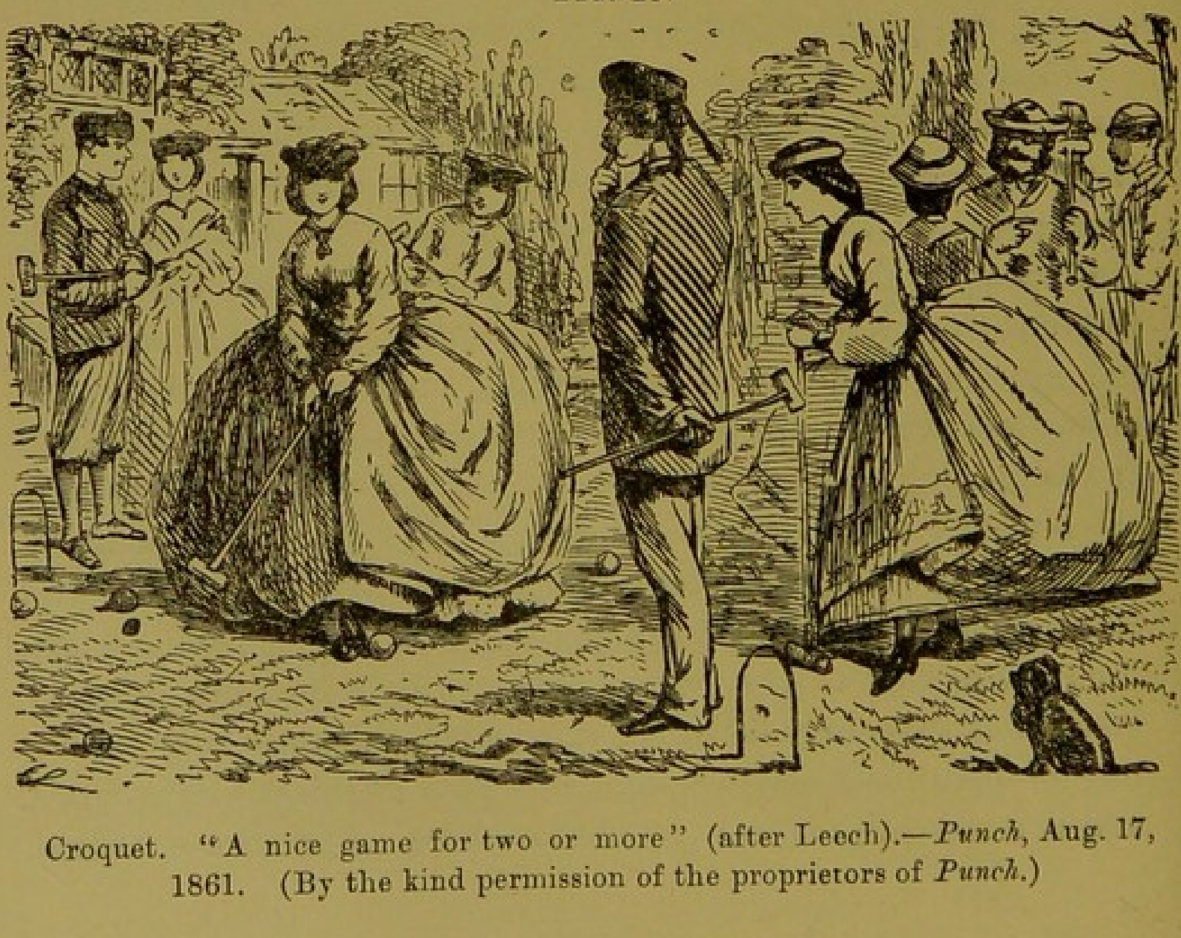
It is evident that pure air ought to be supplied so that the class room to which the children return after exercise should be thoroughly ventilated while they are out and should be well ventilated also while they are in the room, care being taken to avoid draught. Fresh air does no harm, even when cold, provided it be not in the form of a draught, but there is a good deal of truth in the old saying, " If wind blow at you through a hole, make your will and sain your soul." Widely opened windows do little or no harm, even when the air is cold, as is well shown by the modern treatment of consumption, but little draughts are, I think, dangerous, especially if they impinge upon the back or side of the head. Cold air is objectionable if inhaled in the wrong way. The story of the creation of man, as given in the Book of Genesis, is " that God breathed into man's nostrils the breath of life and he became a living soul." There is a great deal of instruction in this passage. The nostrils, and not the mouth, are the normal passage for breathing, and when people forget to breathe through their nostrils and use their mouth for the purpose, they run great risks. The nose is provided by nature with a beautiful apparatus for warming the air, something like the most modern pattern of stoves, of convoluted bones covered with mucous membrane loosely attached to them, so that blood may flow through it in large quantities whenever necessary and warm the air which passes over them. The mucous membrane is covered with cilia which are constantly working so as to eject any microbes which may settle upon them, and thus the risk of either impure air or cold air reaching the lungs themselves is reduced to a minimum so long as persons breathe through their nostrils. Whenever it is found that children cannot breathe through their nostrils but breathe through their mouths, the nose should be inspected by a medical man, and, if possible, any adenoids which obstruct the nasal passages should be removed. If I pass the air which I expire from my lungs into lime water it becomes turbid, and if I blow upon a mirror it becomes dimmed. These facts show that the air from the lungs contains carbonic acid and water vapour, the same products which issue from the funnel of a steam engine. I show you these simple experiments in order to remind you that the power exerted by the human body and by the steam engine is alike furnished by the combustion of carbon and of hydrogen. It used to be thought that the body differed from a steam engine in this respect, that whereas the steam engine only consumed the fuel that was thrown into the furnace, the body consumed its own mechanism and, in fact, burned off its own muscles. It was, therefore, considered that a large quantity of nitrogenous food was necessary for severe muscular exertion. This is now shown to be a mistake. Carbon and hydrogen are the force-yielding ingredients of animal food, though proteids containing nitrogen are necessary to supply the wear and tear of muscles just as a certain proportion of iron and brass are required to repair the wear and tear of a steam engine. But if the carbon and hydrogen of the food be insufficient, or if the exertion be too great, wear and tear goes on in the muscles to a much greater extent than normal. The excretion of nitrogen is greatly increased, and, where food is insufficient and exertion very great, instead of the muscles becoming larger, stronger, and better adapted for exertion, they become weak and atrophied, and in order to avoid such a catastrophe, if physical exercise is to be carried on efficiently, the necessary food must be supplied. But I have already mentioned that it is not merely the muscles which become fatigued, the brain becomes fatigued as well, and just as the muscles need rest so does the brain, and an ample allowance of sleep is requisite for everyone, but more especially for growing children. The physical exercises recommended in the syllabus of the Board of Education are most useful for the purpose of exercising all the different muscles in the body for training the nerve centres in the co-ordination of simple movements. They also tend to develop the higher centres by teaching obedience to the word of command, but, as the syllabus very truly says at p. 10, it is of the first importance that adequate provision be made for such exercises as running, leaping, skipping, preferably in the form of play.

Pleasure is a most powerful stimulus to the nervous system, and I think it is of the utmost importance that physical exercises should be regarded by children rather as play than as work. It is in play, especially play with ball, that some of the highest forms of co-ordination are developed, where the eye has to watch the movement of the ball through the air, and hand, foot, and trunk must all be ready for immediate action while the brain is engaged in judging distance and supplying the movements to be performed. Games of ball are amongst the oldest of all games. We find them pictured on the tombs of the ancient Egyptians. We know from the classics how much they were practised in Greece, and we see from the cricket of the present day not only how much enjoyment they give in youth but how much exercise they induce men of maturer years to take. But play requires playgrounds, and it is not always easy to obtain these. Sometimes, indeed,

FIG. 24.

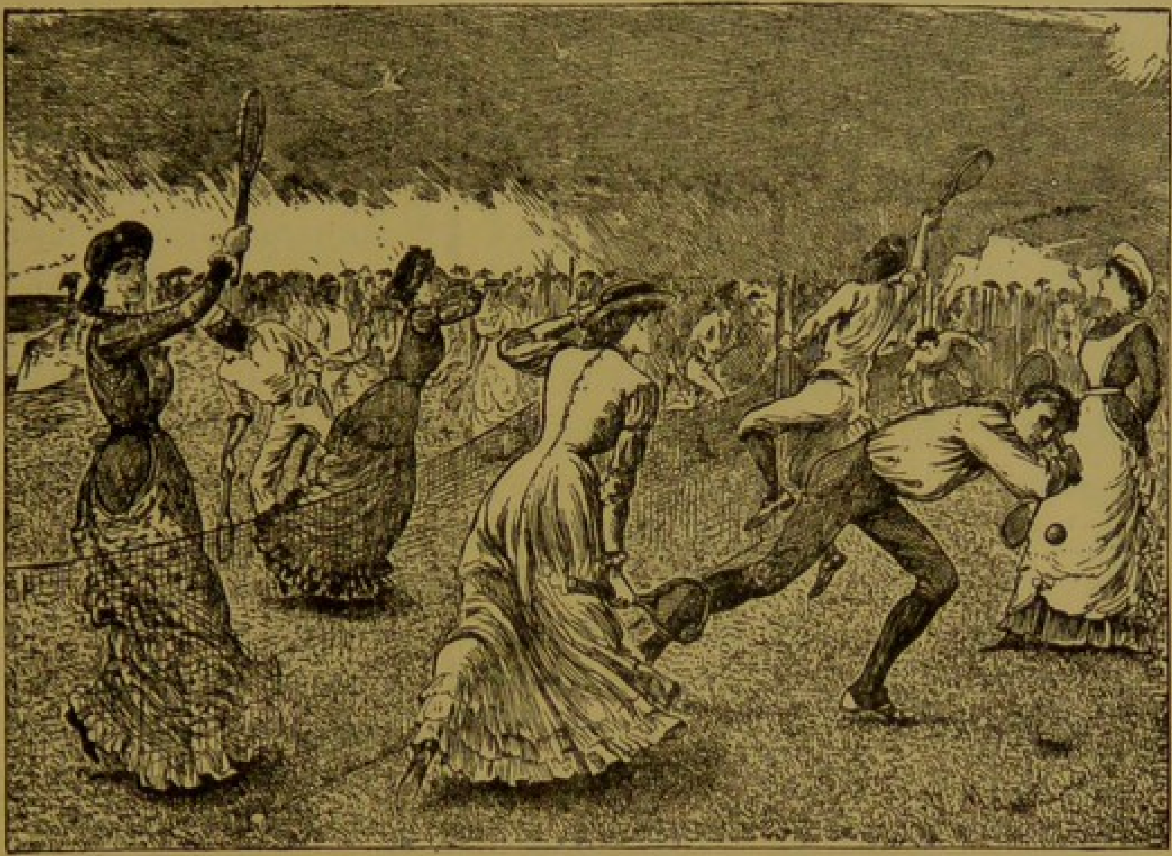
A constitutional walk. "An agreeable duty" (after Leech).—*Punch*, March, 1848, vol. xiv, p. 124. (By the kind permission of the proprietors of *Punch*.)

FIG. 25.



Croquet. "A nice game for two or more" (after Leech).—*Punch*, Aug. 17, 1861. (By the kind permission of the proprietors of *Punch*.)

FIG. 26.



Lawn Tennis. "A modern tournament" (after Du Maurier).—*Punch*, Sept. 3, 1881. (By the kind permission of the proprietors of *Punch*.)

FIG. 27.

Polo. "The lists at Hurlingham" (after Du Maurier).—*Punch*, July 24, 1886. (By the kind permission of the proprietors of *Punch*.)

it may be impossible for the educational authorities to do so, and then they must fall back upon private enterprise. It is impossible, I think, to estimate too highly the admirable work which is now being carried on by the Board of Education, but assistance from without is wanting, assistance in which every man, woman, and child in the country ought to take part. With an object of trying to ensure this an association is now being formed for physical education and improvement.* The success of this will depend very much upon the teachers throughout the country, and it is to be hoped that they will give it their most earnest support. With increased physical training we may, I think, safely expect a distinct improvement in the physique of the people generally, such as appears to have taken place in the physique of women, especially of the upper classes, within the last forty years. This is well shown by the pictures in 'Punch' which, with the kind permission of the proprietors, I show you. In the first of these you see the old-fashioned constitutional walk, in the next, croquet, in the third, lawn tennis, and in the fourth, polo (Figs. 24, 25, 26, and 27). Whether increased physical exercise can be the only cause or not of the marked increase of the size of women in late years, I cannot say, but at any rate it seems probable that it is the most important factor, and we may trust that what it has done for the upper classes it may do for the whole country.

* Since this address was delivered, this association has been formed, and is now incorporated as "The National League for Physical Education and Improvement." It is a league for the good of the nation at large, not for any class, sect, or creed, and it is therefore strictly non-political and undenominational. It is not intended to replace any association at present existing, but to establish a close connection and co-operation between all societies and individuals at present working for the physical welfare of the nation. For this purpose it will try to assist the working of organisations already in existence, and to start them where at present there are none. In order that all classes may join the League, the subscriptions vary from one guinea annually, or ten guineas for a life payment, for Fellows, to five shillings annually for Members, and one shilling a year for Associates.

Payments may be made to, and any desired information obtained from, the Secretary, 49/50, Denison House, Vauxhall Bridge Road, London, S.W. (near Victoria Station).

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