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THE PHYSICAL EDUCATION OF BRAIN and BODY.

AN ESSAY

(International Congress of Physical Education, Paris, 1900).

By

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THE PHYSICAL EDUCATION OF BRAIN AND BODY.

I.—GENERAL.

THE ideal problem of Physical Education, under existing circumstances of civilization, is not very different from what it has been at any other period of the world's history. Let us write MAN in capital letters to indicate the ideal man who is physically, intellectually and morally strong, who has every virtue and no vices, who in his struggle with his environment is obliged to spend much of his time and strength in self-preservation, but who, when assured of food, shelter and safety, can spend it in pleasant labour for the good of others and in cultivating his nobler faculties by the pursuits of Science, Art and Religion. The problem is how to modify the body, and through the body the brain, of the average man, so that he may approach as nearly as possible to the ideal MAN whose body is an "instrument upon which his will can play whatever tune it likes."

Lord Bacon says: "Certainly it is heaven upon earth to have a man's mind move in Charity, rest in Providence, and turn upon the poles of Truth." It is no doubt beyond the scope of Physical Education to deal with spiritual matters, but that "strong reliance on God, natural to great and generous natures," must not be lost sight of in enumerating the attributes of the perfect MAN. Without this the strong man may be merely a tyrant. Many will object that to set too high a standard is to make education unpractical; I am not of that opinion. It is true that the men we want to perfect are not in a physiological state, they are practically either

(1) pathological, or at least

(2) unevenly nourished;

but I have unlimited faith in the powers of Nature to restore even the poor individuals we are, provided we interpret her operations correctly; this is what we have failed to do, and the fault is our own. Almost every professor is more anxious to teach his own specialized "points," magnified to undue importance by the action of an imperfectly-balanced brain, than to be an humble student at the school of the great teacher Nature,

and the same objection usually applies to the numerous discoverers of "natural" means of cure.

Looked at from the highest standpoint the statement that the physically perfect MAN is mentally perfect is true, but if the terms in this proposition are used in their vulgar acceptation, it is nonsense. The public call a celebrated athlete a physically perfect man, when his brain power and faculties are probably more imperfect than in many a half-starved schoolmaster; neither is he long-lived. The term requires definition therefore, and before it is understood what is meant by a physically perfect man a correct idea of the construction, the maintenance, and the function of the organs of the body, (1) taken separately and (2) taken as a whole, must be obtained.

It would seem that to do this one must be conversant with all details of anatomy and physiology, but this is not so. A few general propositions in familiar language, aud constituting admitted tenets of physiological science will be enough to take on authority—most of the rest one can logically accept or reject for oneself.

Every man or woman born of healthy parents without special hereditary tendency to disease is at birth potentially perfect physically, by which it is meant that each of his organs, and therefore his system as a whole, has a strong tendency towards perfect full development, which each one and the body generally will attain if during development and life the most favourable conditions are always present, and therefore the growth of each organ encouraged and helped.

What are the means available to secure to men as they are these favourable conditions?

From statistics gathered as to the habits, diet, and exercise of long-lived men of note the most appropriate advice to give to those who believe that such habits are the direct cause of success and longevity (a very doubtful conclusion all the same) would seem to be—Keep always active, but do everything in moderation; do not eat or drink or sleep or use any particular set of organs to excess, and above all do not *worry*; so will all organs preserve their proper balance.

Many are convinced of the value of equilibrium of the human faculties, but get puzzled from not recognising the fact that such equilibrium is not that of the spokes of a wheel, but that of a balanced hierarchy such as exists in a well-ordered business firm between the proprietor, manager, clerks, workmen, &c. For instance, the appetites must be under the *control* of the intellect; it is not sufficient for them merely to be indifferent and *not* to rule it.

The proper maintenance of this normal equilibrium is upset by a number of causes, physical sins, of which we and our neighbours are every day, almost every hour, guilty. The lazy do not work, and the workers do not rest. The proper balance

between work and recreation is a tempting subject to enlarge upon, but I must pass it over.

Man's anatomical configuration is definite and regular and so stable that few individuals are deformed. Shall we think that the natural stability of his physiological functions is any weaker or less definite? Rather let us seek the cause of short lives and mental deformity in something brought in through a departure from natural ways. We must not lose sight of the fact that such improvements in hygiene and sanitation as tend merely to prolong the lives of the diseased are of no benefit to the race, but on the contrary a very serious and potent cause of its degeneration.

It has been said that twenty-four hours in bed or a day of lounging will do more to restore a tired or over-taxed liver than will any amount of athletics, and that the most valuable factor in physical development is repose. If there is any truth in this, and if others maintain with more persistence that exercise and work are the great remedies for modern evils, it is evident that the advocates of each can only be partially right. Their principles are to be harmonised perfectly *on a nutritional basis*. Both repose and exercise are beneficial in so far as they serve to further the nutrition of the organ or organs rested or exercised, and harmful in so far as they hinder this nutrition.

"We cannot carry on the education of a soul and a body separately; is is the whole man we have to develop," says Montaigne. Must we not admit that hitherto the only methods in use are—a faulty mental education at the expense of the body, or a bodily education at the expense of the mind? Says an American author:—"It is in the powers of reasoning from observations, in co-ordinating the phenomena of nature, pointing out their relations, and deducing laws from the observed phenomena, that the limitation of the human brain is seen at the greatest disadvantage. To one accurate and original reasoner there can be found a thousand original and accurate observers—men who can see and hear and feel without being able to go behind the phenomena that strike their senses and explore through dark and devious pathways the domain of general law." "Exercise every part of the body, and you will have perfect health," it is said. This is the only general principle known to physical education, and I ask observers of human nature, are those methodical specimens of humanity who endeavour to carry this principle religiously into practice the most admirable persons we know of? If they are not, and if by following the habits of the long-lived men of note as referred to, we become neither men of note nor live very long there is surely something very wrong with our science.

The causes of physical degeneration of the human race, *i.e.*, causes of disequilibrium of individuals, are that in substituting for natural conditions those of civilization man's intellect is too

small and his views too superficial to do it wisely. He adopts methods which give momentary benefit and remains blind to their lasting harm.

Sir James Paget once said: "Twenty million weeks of time are annually lost in England and Wales on account of sickness alone." Does this speak well for the advance of science?

I desire to put before this Congress my conviction that the only general principle physical education possesses, viz.: that the development of an organ is proportional to its use, is unscientific, leads in its application to many inconsistencies, and cannot serve as a basis for further progress; but that, on the contrary, the principle that development of an organ is proportional to its nutrition (abundant supply of blood of good quality) is scientific, leads therefore to no inconsistencies, and is an absolutely firm and sufficient basis for a definite scientific method of physical education.

Particulars of a practical method based on these principles will be put before the Congress at another session.

When it is affirmed or inferred that the highest physical perfection leads to mental perfection, it must be distinctly understood that only a physical perfection of brain can be meant. A man cannot become wise by merely training his body to a perfect equilibrium. A whole *Bon Marché* of goods is soon worth little if your only storehouse is an enclosure in the open field, nor is a British Museum library of practical value if you have no catalogue and the books are in one large heap. So a physically perfect brain simply means a perfect apparatus for easily receiving, storing, keeping in good order in their proper places for future use such ideas as are presented to it. The man with a physically perfect brain is only potentially wise; he may become so or not. The possessor of a physically imperfect brain is not potentially wise, though he may use every endeavour by study and experience to become so. Even if a man cares nothing about the state of his body, the quickest way to educate the mind is to begin by giving the best possible health to the body. To a man with perfect physical development in every department it is no task to acquire any branch of knowledge which it is to his interest to acquire. But the physical development I refer to is not, emphatically not, that of the athlete or gymnast.

The term "scientific" is nowadays in everyone's mouth, and is used by persons having little notion of the precision and care necessary before the term can be legitimately used. No man has a right to proclaim a discovery as scientific until he can say, "My observations, which are as exhaustive as it is possible for me to make them, have in every instance confirmed the hypothesis that the single effect *b* is the consequence of the single cause *a*, and as the observations are independent of opinions and based solely on facts (which anyone can verify for

themselves) these observations prove that the invariable following of the cause *a* by the effect *b* is a 'law of nature.'"

Man in perfect health of mind and body finds equal pleasure in work, in recreation, and in sleep. Distorted men with unequal development take, some of them, no pleasure in work, others no delight in play, others no pleasure in sleep. Pleasure of all kinds comes from nervous change. So that we find that of the three—work, recreation, and sleep—it is only required to love the first in a healthy and not morbid fashion, to enjoy the other two as a matter of course. Continuance of work brings a desire for change when body or brain is tired; recreation is delightful, and when recreation is no longer a change sleep is the pleasant alternative. But in distorted natures, as the majority of us have, there is not enough physical energy to make work a pleasure even after recreation and sleep. Work is, therefore, forced upon most of us as a toil, which at all events is better than trying to have "recreation" all day. He who tries to divide the twenty-four hours into play and sleep soon finds that he can do neither one nor the other, and has set himself to worse toil than working.

But even granted that we have found a scientific system of Physical Education, it is one thing to possess it and another thing to make the public, and even to make men in authority, grasp the value of it. Darwin says:—"The limit of man's knowledge in any subject possesses a high interest, which is perhaps increased by its close neighbourhood to the realms of imagination," and we shall always find more interest displayed in metaphysical and religious methods of influencing a man's brain than in studying the regularization of the blood-flow in his capillaries to the same end. Yet Descartes has said, "Si l'espèce humaine peut être perfectionée, c'est dans la Médecine qu'il faut en chercher les moyens," and I feel certain that the members of this Congress are also convinced that if only we can perfect Physical Education, Physical Education can perfect the man—body and mind. By medicine Descartes meant of course physical methods as opposed to others.

Parents constantly deplore the evident impossibility of putting old heads on young shoulders. As the way to do this is probably undiscoverable, the next best thing is without doubt the setting of young shoulders under old heads.

One of the greatest drawbacks to the general adoption of natural means of perfecting human nature is that, go where you will, methods as well as things are constantly preferred and valued in proportion to the amount of human effort they have cost in their production or attainment. In cases where the advantages of the adoption of the natural methods are instantly obvious men use it, it is true, as for instance in sailing a small boat when wind is favourable, instead of rowing it; but in all instances where the advantages are not immediate or obvious

human effort seems to be preferred—a doctor's prescription to fresh air, and an expensive diet to a plain one.

"How delightful it is," says Aristotle, "to make individuals happy; but to effect the happiness of states is an employment still more divine." Even if open to question whether a state composed of happy individuals is necessarily happy, there can be no doubt whatever that unless the individuals forming a state are happy, it is a mockery to call the same a happy state, however good the government may be.

It follows, therefore, that the happiness of the individual is an absolutely essential step to the happiness of the state. Happiness is individual and subjective, in spite of vulgar opinion to the contrary, and the best system of physical education will always be the one which best secures to the individual the happiness inseparable from that calm, healthy, natural life in which each organ is in vigorous health, and the intellect and emotions duly exercised.

II.—SCIENTIFIC.

IN the presentation of scientific theories regarding a complex whole such as is the human organization, a natural basis for the classification of facts is just as important as that the facts should be clear and fully verified. It is true that the "aim of science is always to reduce complexity to simplicity," but, although by process of analysis we can reduce a complex whole to a sum of simple parts, it is not enough to analyse anyhow, or we may fall into the same sort of error as a man whom someone has described as sorting the books in a library into novels, octavo volumes, books on travel, books bound in cloth, and historical works; the basis of an analysis must be adapted to the purpose in view, and the divisions must be mutually exclusive. Analysis on proper lines will always sooner or later make for progress; analysis in contravention of the above principles leads only to multiplication of words and useless confusion of facts.

The present paper is an attempt to put the subject of Physical Education in a new light which shall satisfy all scientific requirements. Its simplicity may offend some who are accustomed to think that true science is inseparable from long sentences and long words. It is nevertheless true that although we possess excellent and elaborate treatises on physiology embodying the labours of thousands of patient investigators, Physical Education as at present treated may be an Art, but it is no Science. It must, I believe, be admitted that the Physiology of Exercise has never yet been placed upon a scientific basis, notwithstanding the efforts of enthusiasts in Sweden, England, America, France and Germany. One recommends one form of exercise, and one another, but none give any rational explanation of their preference, the selection of exercises being purely empirical. Our chief aim must be to perfect man's brain and nervous system; but it is well known that athletes, however gigantic their bodily frames, are anything but giants in intellect.

In a scientific paper no statement should be made without indication being given of at least the manner in which definite proof of its truth can be obtained. As the time available at this Congress for a single paper on the subjects of a single section reduces it to little more than a syllabus, I shall be forced to make apparently dogmatic statements without adducing proof. I hope it is permitted to me to say that such proofs have in every case been obtained by me whenever possible, and will be willingly afforded to members who are interested.

The only general principle of Physical Education I know of, viz., that *the development of an organ is proportional to its use*, is, I venture to say, unscientific, leads in its application to many inconsistencies, and cannot serve as a basis for further progress. On the contrary, the principle that *development of an organ is proportional to its nutrition* (abundant supply of blood of good quality) is scientific, leads therefore to no inconsistencies, and is an absolutely firm and sufficient basis for a definite scientific system of Physical Education.

I proceed to justify my statements, and perhaps may be allowed to mention that practical results, of which I have obtained a large number, have confirmed the validity of the principles I am putting forward, and this not only in a satisfactory way, but in that striking manner which one takes as the best possible criterion of truth.

The problem of Physical Education, considered scientifically, may be stated thus:—Given a human organization, consisting of Nervous System, Senses, Heart and Blood Vessels, Lungs, Blood, Digestive Organs, Muscles, Skin, Bones, and which (by Nature's guarantee) will work well if each is regularly supplied with ample quantity of blood of good quality—given such an organization, what are the means available for ensuring this nutrition without spending too much time over what is really only a means to an end, viz., that of the well-being of the individual? Evidently the solution of the problem lies in the formulation of the best practical means of regularly providing each of the parts of the organization with

Firstly—Blood of good quality;

Secondly—Blood in regular and sufficient quantity.

(1) Blood of good quality is ensured for all the parts of the body by the same means, viz., proper action of all the organs of digestion and assimilation, and on condition that food, air and water are taken in proper quantity and are of proper quality. It is necessary to state, however, that to ensure the blood in the body being always as pure as possible (and purity of blood circulating in the brain is an absolute essential for clearness of intellect, perhaps the highest goal Physical Education should aim at) it is indispensable not only to supply the digestive organs with good food, air and water, but to make ample provision that the numerous poisons belonging to three classes

(i) those unavoidably introduced with the ingesta;

(ii) those resulting from natural bodily processes, *e.g.*, lactic acid, uric acid;

(iii) those resulting from undue internal development of microscopic organisms (*e.g.*, fermentation);

are eliminated regularly and thoroughly.

(2) We come now to the question of quantity of blood supply to the different parts of the human system, and these parts will be taken in order.

First, regular and abundant supply to *Nervous System.* Any nerve centre in any part of the nervous system may fail to receive its supply of blood in proper amount from either of four causes—

(*a*) Obstruction of capillaries by foreign matter (uric acid, &c.).

(*b*) Diminution of calibre of capillaries from disuse of nerves governing same (this is more important than disuse of centre in question itself).

(*c*) Hardening of walls of arteries.

(*d*) Heart weakness.

The practical means for overcoming the first difficulty is to ensure pure blood by means already stated; for overcoming the second either regular use of the centres (whether corresponding to voluntary motion, intellectual acts or emotions) or by vaso-motor influence (change of temperature, rubbing, hydropathy). The third will disappear only as a consequence of general improvement to the whole system, and the fourth is to be overcome by ordinary exercise.

The specially important question of the influence of muscular action of different sorts upon the nutrition of the brain and upon the intellect will be briefly dealt with under the head of muscle.

In attempting a categorical enumeration of the means at the disposal of Physical Education for maintaining a high efficiency of function of all parts of the human body, it is difficult to avoid encroaching on the one hand on the domain of Hygiene, and on the other hand on that of Mental Education. If we exclude the question of food, drink, and air, the importance of the purity of which is paramount and which belongs to Hygiene, the means necessary and sufficient to ensure a normal state of perfect health of mind and body are simply

Exercise and rest of muscles;
Exercise and rest of brain;
Hot and cold baths, or their equivalents.

(The very special form of exercise for the muscles afforded by "full contraction" will also be dealt with later.)

Of these means the chief for affording proper nutrition of the *brain and nervous system per se* are: Use of the different parts of that system (avoiding excessive use or fatigue, avoiding over-cultivation of one part at the expense of another), baths, or their equivalents, which afford a sort of quick wholesale means, through the vaso-motor system, of governing the blood supply of the different parts, and avoid the otherwise tedious

necessity of regular cultivation of *every* part of the brain and nervous system. All *work* done in the body has an injurious effect on the nervous substance, which is very susceptible to the influence of the poisonous products of fatigue. The clearest brain is the one which is kept most free from all poisons, and the dilemma of Physical Education has hitherto been that the means at its disposal (muscular work) has made it possible, it is true, to improve the circulation and eliminate some poisons, but not to keep the blood free from the products of work. Does not Ruskin say as much when we read: "You can no more filter your mind into purity than you can compress it into calmness; you must keep it pure, if you would have it pure?" Sir Michael Foster points out this difficulty very clearly when he says: "If an adequate stream of pure blood, of blood made pure by efficient co-operation of organs of low degree, be necessary for the life of the muscle, in order that the working capital may be rapidly renewed and the harmful products rapidly washed away, equally true, perhaps even more true, is this of the brain."

Nervous energy is difficult to define, except as (1) the cause of muscular tonicity and (2) the medium indispensable to the existence of conscious thought. It is produced as a result of normal chemical action in the body, the production being continuous. As continually as it is produced it is being used up, or, perhaps, leaks away. As the tissues of the body vary with the quality and the quantity of the blood supply so must the production of nervous energy. Oxygen is a most important element in its production. The specialist by constant use of one part of his brain increases the normal circulation in that part, and therefore his capacity for prolonged attention to the speciality. But other parts of the brain proportionately suffer, and we see the "littleness of greatness" in the lack of "common sense" habitual with the "genius."

Nutrition of voluntary motor nerve centres.—The use of these centres leads automatically to an improved supply of blood to them, and in the practical application of this principle the chief fact to be remembered is that by constant repetition a known series of movements soon becomes reflex and unconscious; in other words the voluntary nerve centres are no longer excited. Hence in selecting exercises for performance in class, the necessity, if voluntary nerve centres are to be exercised and nourished, of making each movement an unexpected one. The greater the nervous impulse brought to bear on the movement, the better will be the corresponding nutrition of the centre—hence the necessity for brisk orders and brisk movements. Lazy performance of gymnastics is of no good for nervous development.

Satisfactory nutrition of centres not specially used is often brought about by securing good change of blood in an adjacent

part; in fact, generally speaking, nutrition of any particular part can be well secured by affording copious blood supply to a part immediately adjacent (*e.g.*, nutrition of mucous membrane of the back pharynx can be readily improved, even to the point of causing disappearance of pharyngitis, by full contraction of the prevertebral muscles immediately underlying the mucous membrane).

Moderate regular use of the *Senses* is sufficient to maintain them in excellent order through life if the body generally is in perfect health and the blood pure.

The *Heart and Blood Vessels*, in order to be maintained in perfect condition, demand some, not necessarily much, active exercise. Probably a much more serious item in degeneration of arteries than lack of exercise is the hardening of their walls from deposition of the excess of mineral substances contained in the blood.

The *Lungs*, in a healthy person, are best maintained in perfect condition, by means of such muscular exercises as give the best possible development to the diaphragm, abdominal, and intercostal muscles; this is easily afforded by a little full contraction exercise. The results are in every way better than that accomplished by the panting attendant on hard work.

In passing to the Nutrition of *Muscle*, we enter the very stronghold of physical education. Every man of exceptional natural strength possesses very large muscles, but it is only of late years that we are beginning to see that the converse proposition—that every man with very large muscles possesses great natural strength—is a fallacy. Still, the popular admiration accorded to huge biceps will live a long time. A system of Physical Education worthy of the name should have prompt and easy means of maintaining good nutrition of every muscle in the body, not only because an even development of all muscles is more beautiful, but because an evenly-balanced body is the natural habitat of an evenly-balanced mind.

The man with real natural perfection of physique has muscles and nerves just as well prepared for using a sledge-hammer as an engraver's tool; but in the ordinary individual, even after much dumb-bell, "exerciser," or other gymnastic work there are many muscles left very weak indeed. It is very seldom that the movements used either for work or athletic recreation involve true "full contractions" producing the greatest possible shortening of the muscles compatible with its attachments. When this does occur, however (*e.g.*, in skating, with the muscles of the calf), it can be observed how very rapidly such muscles develop compared with others used as frequently but only partially contracted. This result is independent of the work done, *i.e.*, of the exertion put forth. Full contraction completely removes from the muscle the venous blood charged with waste products which accumulate there from a multitude

of causes, and leaves it replenished with the best nutritive fluid circulating in the body at the time. And six or eight "full contractions" properly done are sufficient to attain this end, one not obtained by any modern form of exercise whatever, for with partial contractions, if gentle, the blood is not changed in the smallest capillary vessels of the muscle, and if severe the latter is fatigued and waste products abound in it at the moment it commences to rest. Muscles will respond instantaneously and perfectly to the mandates of the will if they are all in perfect order, but if weak the commands given to the nerves are not obeyed and their movements are made awkwardly.

The kernel of the whole matter of muscle development and control lies in the physiological discovery to which I was led after a number of years' study of the problem of how best to acquire the highest perfection of command over muscular movements for performance on musical instruments. "Full contraction" as a means of muscular and nervous development may seem too simple to be called a "discovery," but the importance of it compared with every other sort of contraction, with or without resistance, has curiously enough not been noticed before, and the results of its uses are as astonishing as the principle is simple. The generally-accepted idea about acquisition of strength and control of muscle has been that a muscle developed in proportion to the amount of regular use it got, as has already been said. That this is only part of the truth is shown by the fact that in numbers of professions constant use of muscle brings on atrophy and cramp, which it would not do if such exercise were healthy. If you skate, for instance, for six hours a day you will enormously develop the muscles of the calf. If, on the other hand, you play the piano for six hours a day you may cause cramp and atrophy instead of development. The explanation is—that a muscle develops, when used, in proportion to the regular supply of nutrition such use brings in ; if the use is of a description to change the blood frequently, the muscle will be improved, if not it will remain in the same state or deteriorate. These statements are susceptible of thorough scientific proof.

The results of muscular inactivity on the mind are that the brain becomes liable to a morbid activity, and is alert but weak. Characteristics of the sedentary student are irritability, prejudice, intolerance, due to non-elimination of products of tissue change and to general unevenness of nutrition.

The results of muscular work on the mind are that the brain is dulled by a general lowering of the activity of the highest nerve centres. Ignorance, credulity, placidity, are the mental characteristics of the labourer, due to action of waste products of work on the nervous system. Full contraction exercise perfects muscle and perfects nerve-control without causing a single one of these ill effects.

III.—PRACTICAL.

HAVING already given to the Congress a sketch of the general principle of even nutrition of all organs as a basis for physical education, I now proceed to give an idea of the methods employed for its practical application. As far as development and control of hands and arms are concerned I have had experience with over 1,000 cases, and a certain number of these have been dealt with for improvement of the system generally. Details of success obtained can be afforded to those interested.

If, as cannot but be admitted, the nutrition of an organ is of primary importance, the non-obstruction of the capillaries carrying the nutritive fluid must evidently be of equal moment.

Practically, given a channel of a given size, through which a flow of liquid is sluggish, the latter may be corrected either by

(1) increasing the pressure on the liquid, or

(2) diminishing the viscosity of the liquid.

"Full contraction" exercise ensures, in a special manner, perfect nutrition of *muscle*, but for other parts of the body these considerations show the paramount importance of (1) using a little regular daily active exercise to cause increased heart action, and (2) of keeping the blood in a liquid state, *i.e.*, as pure as may be; this is the function of a proper diet.

The number of the muscles in the body is so great and their attachments so irregular that the task of discovering a series of movements which, without being too numerous for practical use, should embody the requisite full contraction for every muscle of importance has been a long and not a very easy one. It has been thoroughly carried out, however, and hardly a single muscle, however small, is excluded from the series.

It is obvious that a large and rapid increase of muscular development, such as occurs when the muscles are deliberately fed in the manner described, must involve, when the condition of the body is that found in most town-dwellers, an unusual call upon the nutritive elements of the blood; it is therefore equally obvious that such development must be allowed to take time, and it is found that only about five minutes' use of the new exercises, twice daily, can be indulged in to begin with even by fairly strong and healthy men. On this plan a feeling of general well-being does not take long in making its appearance, whereas if too much of the strength of the blood were imparted to the muscles the nervous system would of course suffer, and languor, depression, weakness, would be felt for a time.

Confirmation of the value of full contraction can be readily

adduced from physiological considerations on the development of the gluteus maximus muscle in the human subject, but as each person can so easily prove for himself what full contraction can do I do not think it necessary to do more than mention such proofs. The value of brisk "full contraction" exercise may be explained as follows:—The nervous impulse, which by stimulating the muscle causes it to contract, produces at the same time a dilation of the small arteries leading to it. The stronger the nervous impulse the greater the increased supply of blood, and it is on this account that the exercises must be performed briskly. A full contraction (such as occurs when a muscle is contracted until for the moment it is quite hard) causes compression of the small blood-vessels in the muscle, and as any pressure upon veins causes the blood to flow onwards towards the heart, the blood from which the "goodness," so to speak, has been extracted goes on its way to the revivifying lungs, and its place is taken by fresh blood from the arteries. It is during rest that the muscle develops by feeding upon this blood left in it.

As the muscles form 40 per cent. of the weight of the body it is of the highest importance to the general state of health that their nutrition be kept as perfect as possible; regular full contraction of them is the only means necessary.

After an exhaustive study of the attachments and action of 170 pairs of muscles in the body I have found it possible to condense into about thirty the movements which shall give full contraction and ensure the perfect nutrition of practically every one required for general purposes. As examples I will give you practical illustration of the movements affording full contraction of some special muscles. I have chosen for illustration two large muscles of irregular shape, the nutrition of which is of great importance from the points of view of health and of graceful carriage of the body—the *latissimus dorsi* and the *trapezius*.

Latissimus Dorsi.—On Right Side.—The movement is very much like that made in putting the hand to the bottom of the tail pocket of a coat. Stand erect, twist the body a little to right and somewhat backwards, as if for the movement described, and bring the right arm round in such a manner that the fingers of the hand are made to project round and beyond the left hip as far as possible, the back of the hand being of course against the body. The criterion of the exercise being done properly must be a feeling of strong contraction in the broad muscle of the back situated below the right shoulder-blade.

On Left Side.—The corresponding exercise for the left side is symmetrical: Make these movements thoroughly once with the right and once with the left arm alternately eight times each.

Trapezius.—This is performed practically thus:—

Right Shoulder-Blade.—Place the right hand behind the

back keeping the palm turned towards the body, and brace the right shoulder-blade towards the spine. The hand must be kept behind the back and the shoulder-blade braced to the spine throughout the whole of the exercise. Now push the right hand straight downwards as far as is possible, which is effected by the full contraction of muscles which pull down the shoulder-blade (first position). Now, keeping arm still behind the back and shoulder-blade braced, raise the shoulder-blade as far towards the neck as possible, bending the head backwards till it feels to be meeting the top of the shoulder-blade (second position). You will observe that this second position is precisely that made by a child on being tickled in the neck. Pass quickly from the first to the second position and back again, and repeat the double movement eight times.

LEFT SHOULDER-BLADE.—When quite familiar with the above exercise it will be found easy to perform it similarly with the left shoulder-blade, repeating the movement eight times as before.

This muscle has, I believe, never been satisfactorily dealt with by any apparatus or drill hitherto used, and if military men have ever acquired good development of it this is due to the fact that they are constantly thinking of holding themselves straight, thus training the nerves of the *trapezius*, and indirectly, at the cost of much time and trouble, improving the muscle.

The rotator muscles of the leg, viz., *semimembranosus*, *semitendinosus* and *popliteus*, are developed easily by the following movement. Stand on left leg, resting the left hand on a table. Double up right leg, holding it loosely just above the ankle with right hand. Now twist the foot and leg smartly on itself first to right and then to left as far as it will go ; twelve times the double movement. Change the word "right" to "left" and "left" to "right," and you have the exercise for the other leg. Note that the ankle does not shift its place in this movement ; it only twists round.

These different movements I am in the habit of teaching for individual use by means of written instructions, but a means of using them in class has been recently devised, and as these class movements possess considerable advantage over others I know of I am hopeful that they will become widely used. These advantages are :—

1. No apparatus whatever is required.
2. Two persons may use them together, one "setting" exercises to the other, or a class may be of any size.
3. They afford endless variety and combination, thus giving the element of interest so necessary for nervous development.
4. No fatigue is involved, even by beginners, in the proper performance of the exercises.

5. Independence of control is acquired at the same time, and this is the essential point in acquisition of grace of movement.
6. Rapidity of control is gained, whereas in ordinary gymnastic work this is lost.
7. No work being done, no poisons are generated.
8. They take up a very little time.
9. They clear the intellect instead of dulling it.
10. They lead to a perfect balance of the body, and therefore conduce largely to perfect balance of mind.

(*Here practical illustration with a friend.*)

As the exercises themselves do not cause fatigue, nor lead to exaggerated respiration, it is necessary to introduce special deep breathing every now and then, or better, when possible, to sing heartily for ten minutes after practising the set.

Some active exercise, such as walking, running, cycling, or, better, athletic games, according to age and occupation, must be taken at least once a week for a few hours if the best health is to be maintained. This rule is only necessary for sedentary persons, as others will get the required amount in the pursuit of their ordinary avocations.

One of the most serious obstacles to the natural expulsion of disease or natural recovery of a weak organ is a sluggish circulation, as the blood moves very slowly indeed in the capillary vessels of a weakened body. "Full contraction" removes this difficulty in such a marked manner that several cases of advanced and long-standing heart failure have been completely cured by its means alone.

But although it is a satisfaction to be able to keep muscles in perfect order so readily, this is not a complete system of Physical Education in itself. When we recognise the fact that growth of muscle, nerve, &c.—any part, depends, not on its use, but upon the nutrition brought about by such use—we are also led to recognise at once, as of equal importance with exercise, for purposes of physical education, all direct vaso-motor influences, *i.e.*, means of affecting the calibre of the blood-vessels.

The chief of these are :—

(1) emotional.

(2) those brought about by excitation of nerves of the skin.

The first influences are brought into play in all ordinary exercise of the emotions; the second are most readily controlled by baths, which afford potent means of equalising the circulation

and, therefore, nutrition. A bath may either (1) cleanse or (2) assist elimination of poisons by perspiration, or (3) cause re-distribution of blood. A Turkish bath does all three—a long hot bath, followed by a cold sponging, does all three; a cold bath only invigorates, and should never be used unless hot or Turkish baths are also employed. Taken alone, cold baths lead to retention of poisons in the system and to a diminished vitality in the functions of the skin.

Fresh Air.—A regular and abundant supply of oxygen is indispensable for normal nervous action. Physical Education demands that the lungs be well supplied with fresh air both day and night.

Now a word upon Food. Nearly all of us eat too much, and in England we eat too much meat. The blood is kept in the purest and most liquid state by the man who eats a moderate amount of properly-selected vegetable food, and takes little or no meat. Although a change of diet is usually somewhat of a trial while being effected, it will encourage any who contemplate it to know the certain reward, which is this, in the words of Sir Henry Thompson: "The desire for food is keener, the satisfaction in gratifying appetite is greater and more enjoyable, on the part of the general light feeder, than with the almost exclusive flesh-eater."

By the means I have described it is possible to develop the best health, the greatest physical beauty, and the best grace of carriage possible to the individual. The principles are, it is true, the reverse of the prevalent ones of specialization, which is of great commercial importance under the name of division of labour, but of the greatest danger to the individual, and eventually to the race. If the man who aims at physical equilibrium persists in devoting his thoughts constantly to one subject, this alone is quite enough to prevent his true, even development: the best health and physical beauty will never exist in a specialist of any description—not even in a specialist for Physical Education.

In the brain, localization of function, as experimentally proved, leads us to the conclusion (independently of phrenological ideas, seeing that a "function" may perhaps be spread over a large portion of the brain) that men differ in character according as different parts of the brain are more developed and alive—*i.e.*, are more readily and pleasurably used. In the individual brain of a "good-natured man" with a perfectly-balanced mind the intellectual faculties and the emotions are normally developed—he uses them all appropriately. By a method which will ensure even nutrition to all parts of the body, it is therefore possible readily to influence a man's character for good, to impart good nature, love of work, strength of intellect, in a definite way which is very different from ordinary mental and moral training, in which the *will* is goaded to superhuman

efforts, often to the ruin of mind and body, and almost as if the will were to be considered the only force in human nature!

Now, as the principle of specialization must, as far as one can see, prevail in modern communities, it is of the greatest importance, if the degeneration which has hitherto followed on civilization is to be retarded, to use artificial means to restore the balance of nutrition throughout the body as much as possible. The physical educator joins hands here, therefore, with the advocates of an eight hours' day and of frequent excursions for the people.

The specialist, either in physical or mental labour, is short-lived. The relation of specialized work to endurance is as follows:—In physical work—*e.g.*, if a definite group of muscles is exercised in a trade—the consequence is, permanently improved circulation to the nerve centres and muscles employed, and improved endurance both from the greater development and better circulation (excepting in the case of exercise involving partial contractions against slight resistance). The blood supply to other muscles and nerves is, however, impaired and their endurance diminished.

In mental work, *e.g.*, if a definite group of nerve cells is exercised in a profession, the consequence is, permanently improved circulation to them and improved endurance in exercise of such profession (excepting in case of overwork, of concentration on a particular line of thought inducing fatigue to the point of failure of organs). The blood supply to other nerve centres of the brain is however impaired, and their endurance diminished.

I believe one is perfectly accurate in affirming that the essence of "grace"—the quality *par excellence* we admire and seek in our fellow men and women, whether on the stage or in the drawing-room, or as an indication of the highest character—consists in what may be more concretely termed "poise," and that this "poise" is virtually synonymous with even development of all muscles of the body. It has certainly not been acquirable to an appreciable extent by the methods of Physical Education hitherto used, but by full contraction is readily attained. For instance, there are certain of the smaller muscles of the leg which cannot be left undeveloped if grace even in walking is to be attained. These are not trained in any of our military exercises, the consequence being that the leg movements of our soldiers at the knee, specially the trained ones, are as devoid of grace as the opening and shutting of a clasp-knife. Dancers do train these muscles, hence they usually acquire some measure of grace.

Analysis of the movements used by the classes of artizans who suffer from "professional neuroses" will lead to the conviction that oft-repeated partial contraction of muscle is the source of the evil; work is done for which the movements do not afford sufficient nutrition and the result is failure, primarily, I believe,

of nerve endings in the muscles, and then of nerve centres urged to excessive effort. Having cured a number of these hitherto intractable neuroses, I am of opinion that each of these professions should publish details of the movements giving full contraction and perfect nutrition to the special muscles they use in an unhealthy way, and two minutes' use of which movements at the close of the day's work would ensure immunity from the neuroses and increased working proficiency.

Generally speaking, equilibrium of the bodily functions will be disturbed by adoption of any profession in which one part of the body is used to the exclusion of others. As the tendency to such disturbances occurs more and more as the specializations of civilization become more numerous, the practical task in general of the physical educator is to see that these other parts are so treated that their functional power never decreases beyond the limits of fair health—in other words, that they receive as good nutrition as is compatible with the specialization required.

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