PHYSIOLOGICAL PSYCHOLOGY OF FATIGUE AND ALLIED CONDITIONS.

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FOR many years we have been accustomed to regard physiology and psychology as distinct branches of science. Results obtained from experimental physiology have been applied to clinical medicine, but little notice was being taken of the advances made in experimental psychology in connection with physiology and medicine.

But the war has done a great deal to upset our conservative ideas, and rapid advances have been made in the past five years in the study and application of physiological psychology. The study is of great practical value in our present industrial problems, in the nervous diseases created by the war, and has also given us knowledge with regard to diseases of nervous origin which have been a closed chapter in medicine for many years.

The question of labour and the employment of discharged service men is a great problem, and scientific investigation is an absolute necessity. Pensions are now fixed mechanically on the disablement. A man who has lost both legs is reported to be 100 per cent. disabled; yet there is plenty of work which he would be able to do if properly trained.

Pensions cannot be fixed on the disability. For instance, the loss of the right arm is not the same to every man; it will depend, to some extent, on the power of the stump. An artificial arm may be fitted, and the man will

be able to resume his pre-war occupation; while, again, another may be able to train his left hand to perform the necessary work; and there still remain those who have not the strength to work an artificial limb, or have not the mentality to train their other arm. Yet all these men receive the same pension. Pensions can only be calculated after the man has been re-educated and his disability scientifically investigated.

We are able to measure the muscular activity required to perform different acts of work and exercise, and so it is possible to see if they can be performed by women and children, and even disabled soldiers. These measurements are obtained by graphic methods, on the lines indicated by the French physiologist Mavey.

The muscles are made to act upon springs, which, under the conditions of the experiment, undergo compression and a slight change of form. Each of these springs terminate in a disc. This compresses a small rubber bulb, which is attached to a tambour. These can be adapted to various tools, and we can measure the amount of work done by planing a piece of wood, or by attaching it to a spade we can get a record of the activity employed in excavation, &c.

Voluntary contractions in man are followed by fatigue, and this can be recorded—*e.g.*, Mosso instrument, the ergograph. The subject makes a series of short contractions of the flexor muscles of the middle finger, lifting a known weight to a definite height.

The intervals between contractions is kept constant, and so is the weight. Fatigue gradually comes on, and the finger is not able to raise the weight, and from results obtained it is easy to calculate the work done.

From experiments performed with the ergograph, the following conclusions were drawn :—

1. If sufficient interval is allowed between contractions no fatigue is apparent.

2. After complete fatigue, a long interval is necessary before the muscle is able to do the work again.

3. After complete fatigue, any further effort during the period of rest tends to prolong the time before the muscle will be able to lift the weight again.

It was also found that alcohol decreased the amount of work that a man was able to do, and brings on fatigue in shorter time.

Now, it is not possible to compare a man or a labourer to a machine, because if an engine is stoked it will run on until the fuel is used up; it can only do a certain amount of work, and under no circumstances can that be altered.

We cannot say the same for man, for in the ergograph experiment the subject will go on working for a period, which is not always constant even in the same subject. It is not the lack of fuel which causes him to stop, nor is it the feeling of fatigue, because when he first feels tired he may do better work than at the start. The thing that stops his work is exhaustion, or the final state of fatigue. Now, as Dejerine and Gauckler state, the man passes through the following stages :—" Getting started," " automatic work," " voluntary work," and " exhaustion."

Therefore, in order to try and make the work of labourer efficient, it is necessary :—

1. To make the worker's movements automatic.
2. To fix the attention of the worker, and so increase the period of voluntary work.
3. To ward off the state of exhaustion or absolute fatigue as long as possible.
4. To have him in good physical health.

Now, first of all, what of automatic work? It can only exist when there is accustomed physical activity. A workman automatically walks to his work in the morning, whether the road is short or long. A workman can work for a number of hours without being conscious of it—in other words, the movements tend to become performed by the unconscious self. Movements of this kind keep off fatigue.

We can show by experiment that the heart will adopt a normal rate when the man is doing accustomed work. The person to be experimented on works an Ergo metric cycle. He actuates the pedals or he works a crank by contracting the muscles of his arm. Records of the heart-beat are taken by the cardiograph, the pulse by the sphygmograph are taken, and arterial pressure is measured. As the muscles continue to work in a normal and regular manner the frequency of the pulse continues to increase; but provided that the work does not exceed a maximum of two hours' duration without an interval for rest, the average frequency of the pulse does not exceed 120 pulse-beats per minute. On the other hand, if the pace of the work done exceeds the usual limits, the pulsations become more rapid. The cardiogram in accustomed work shows signs of systolic plateau, and the maximum arterial pressure is about 25 centimetres.

In performing automatic work we must also strive to do away with unnecessary actions. Take bricklayers, for instance: they have a habit of turning over a brick, and after scraping and placing it on the row, hammering it with the trowel. The efficiency of the worker was increased and the output of work doubled in America when untrained labourers were hired to place the bricks in position, and the bricklayers simply set them. The other superfluous

actions were done away with. It was also found that the efficiency of the tram service was greatly increased by making the position of the tram-conductor stationary at the end of the car. There is only one fare ($2\frac{1}{2}$) for any journey. You pay the conductor as you enter the door.

It was shown that the men did not feel fatigued so quickly, and the time of the journey was cut down, also the number of accidents was greatly decreased.

If the attentions of the workers are fixed, the amount of work done is increased, because it does not allow the mind to stray, and the workers take an interest in their work. It is, therefore, necessary to choose suitable workers for the different occupations, and this has been done in America in many cases by using certain psychological tests.

1. *The Letter-erasing Test*.—A paragraph is read to the subject, who is then told to erase certain letters. The care, steadiness, fatigibility being observed.

2. *The Association Test*.—A list of numbers of 7-10 digits, newspaper paragraphs and pairs of associated words are read to the subject, who is asked to reproduce the numbers, the substance of the paragraphs, and the other member of each pair of words when the first member is read to him.

3. *The Dotting Test*.—A paragraph is given to the subject, who is told to dot certain letters. The time taken to perform the task is noted.

By these methods it has been found that there is a wide range of mentality, and men possessing quicker intellect can be employed at tasks where quickness is essential to efficiency.

Myers quotes a case :—In a bicycle-ball factory 120 girls were employed in inspecting balls for flaws, the balls lying

along the interspace between the backs of the two fingers of the left hand, and defective balls being removed by a magnet held in the right hand. For this work good vision, good powers of observation, and quick reaction were essential. The result of a study of the reaction times of these girls was that some of the most intelligent and industrious of them were found unsuited to the work, and were transferred to more suitable occupations elsewhere. By employing only the most suitable workers, thirty-five could do the work of the previous hundred and twenty. Their hours were reduced from $10\frac{1}{2}$ to $8\frac{1}{2}$ per day. Two days holiday were given per month, their salary increased by 100 per cent., the accuracy of the work was increased by two-thirds, and there was a large decrease in the cost of production of the balls.

It is our next duty to ward off fatigue as long as possible, or, in other words, to keep the man working automatically without calling on his voluntary work.

We can keep off fatigue if we arrange a suitable number of hours for the men to work, and during the working hours allowing certain resting times for recesses. Among certain classes of workmen more work was done in a seven hour day than when the men worked ten hours. The men worked at a higher tension, and did not allow their mentality to play on their task.

If short recesses are arranged during the day, the men return refreshed to their work, and are able to concentrate their thoughts on their task.

The health of the worker is a matter outside this paper, and deals with the question of housing, &c.

The re-employment of the disabled soldier is the problem of greatest importance to-day, and if we apply some of the ideas outlined we can re-educate him, so that he may earn

his livelihood. The loss of a limb or limbs does not mean that he will never be able to work. The power of the stump can be calculated, the sensitiveness of the end of the stump re-educated, and the man fitted with an artificial limb suitable to his occupation. Re-education for labour is necessary, as his organs have suffered from shock, and he must first serve his apprenticeship to re-education before being fit for work.

We have seen how we can increase our efficiency as workers by applying some of the results obtained from experimental physiology and psychology, and we can also improve our own mentality by applying some of the principles of these two subjects to our mental processes.

The war has produced, as a result of exposure, concussion, and physical suffering, a nervous disorder, which has been classified under the term shell shock. But I would rather call these cases hysterical disorder due to war, and so classify them with hysterical disorders, to which they are so closely related.

We unconsciously mould our life on the sensations we receive, and by sensations is meant the first things in the way of consciousness. Now, immediate sensations can only be realised in the earliest days of our life; they are all but impossible for an adult to experience, with memories and store of associations already acquired. Prior to all impressions, the brain is plunged in deep sleep, and consciousness is practically non-existent. The first weeks after life are passed by the human infant in sleep, and a strong stimulus is necessary to break this slumber. This stimulus gives rise to an absolutely pure sensation, and the result is an experience or remembrance in the memory centre which opens a new path of association, and produces cerebral reactions after the transmission of

another impression from a sense organ. A different kind of feeling and higher state of cognition is reached as a result of these stimuli, which go on increasing during life. In general, this knowledge or higher state of consciousness is called perception, and so mentality is evolved, every stimulus adding knowledge and modelling out the character of the individual.

Man lives his life along the line of his training, which is the result of the stimuli received, but another neural activity also plays an important part, and that activity is habit, which can be defined physiologically "as a new pathway of discharge by which certain incoming currents ever after tend to escape."

The functions which man has to perform are so enormous that if he could not economise his labour he would be in a sorry plight. The opening of his coat would be a difficult affair, the morning toilet a tremendous task; it is thus that habit, as a result of the experience of perception, simplifies our movements and makes them accurate. It also diminishes the consciousness with which our acts are performed that tends to make them automatic. It is thus habit works our destiny. It rules the classes, it will not allow members of the lower order to leave their association. It prevents the average man seeking for adventure, and holds him to his daily task. It is, therefore, a very necessary thing to do to make your brain your friend, not your enemy.

The functions of our natural life are closely allied to our psychical existence, and so any disturbance of our physiological functions disturbs the working of the mind. If our physical condition is lowered by fatigue, mental worry will soon bring about abnormal conditions; our emotions become exaggerated, and play a great part in our life. For,

as Deferine and Gauckler write : " For, in the same way by the lowered physic and physical tone to which they subject the patient, they may become factors of a greater emotionalism on one hand, as they also constitute by themselves true causes of emotion on the other hand." It is, therefore, not surprising that new nervous diseases have appeared as a result of the war, because never before in history has there been such a stimulus to emotion, and it is among the sensations and emotions of the body that we must search for the cause of disarrangement. The soldier leaves for the front in good physical condition, hardened for the fight. He has been in training for at least four or five months, and during that time he was taught how to use and handle explosives. But, unfortunately, he cannot train his emotions for the ordeals that are before him. He may on occasions show great fear, or, on the other hand, may appear quite calm, but at the same time suffer great agony, for men suffer fear in different ways. I have seen men who afterwards acknowledge that they were greatly afraid, and yet expose themselves to needless danger, so as to give example to their men.

It is the experience of these emotions, with subsequent suppression, which lead later to neurotic conditions. The emotional states will return to the memory, for no stimulus is ever forgotten or the memory lost. This state of suppression of an ever increasing force, coupled with the strain and fatigue, rapidly produce a neurotic condition, and it only remains for the final shock to upset the equilibrium, and then the man is said to be suffering from an " hysterical disorder." It cannot be said that the shock alone produces this condition, but rather that the shock lights the fuse to the gunpowder.

I saw a man some time ago suffering from general tremor

of the body, but particularly marked in the arms and legs, which increased in intensity when the man stood still. His history was that he was home on leave from France. He complained of feeling tired and of pains in the head. While walking down the street a motor car, which had come up quickly without his noticing it, suddenly hooted. The man collapsed and fell in a deep faint. On regaining consciousness he, to use his own words, began to shake all over, and was scarcely able to walk. After an analysis of his trouble he recovered, and the symptoms disappeared.

Now during the period this man was on active service in France, which can be named "accumulating" period, the man has concentrated his mind sub-consciously on some function or special sense organ. He may develop a hyper-sensitiveness of the part. New paths of association may be opened up; sensations are more easily carried to the brain; the inhibition of the higher centre is lessened, and we have parts of the nervous system easily put out of action.

The psychology of forgetting has lately undergone radical changes, and it is now realised that what is learnt is not forgotten. We may not be able to recall it at the moment, but given favourable opportunity it can be remembered. It is now also understood that things we forget are in reality suppressed by our sub-consciousness, because they connect our memory with some thought or action that is unpleasant to us. Now unpleasant experiences are never forgotten, and even though we banish them from our conscious mind we store them in our memory.

I saw a soldier in June, 1918, suffering from loss of speech. While on duty he had heard some sudden private news, and, without losing consciousness, lost his power of

speech. He wrote on a pad that he had had this same trouble about a year or eighteen months ago after concussion in France. He had, however, recovered, and had no further trouble until this attack. He was cured in one treatment by suggestion. Now, this is a case in point—this man carried the memory of his experience in his mind. The man's consciousness suppressed the memory of his previous dumbness, but which immediately came back to his mind by the stimulus of emotion brought about by hearing sudden joyful news. The effect of the memory on the consciousness was to cause a relapse, and to make the man dumb. The treatment removed the irritation of the experience from his mind, and the man had had no relapse when last I heard from him.

About the same time I examined another soldier who had suffered from loss of speech and general tremors since May, 1917. While on duty in Italy with the R.F.A. in 1916 he went through some heavy shelling. After heavy shelling he found he could not speak without stuttering, and felt depressed. He did not receive any medical attention. He was sent to France from Italy, and in the beginning of 1917 a shell exploded in his gun pit, after which he became unconscious. On recovering consciousness he could not speak, and had such pronounced tremors he was not able to walk.

This case is very similar to Case 2. The unpleasantness of his experience in Italy remained fixed in his mind, and even showed itself by producing stuttering. The consciousness focussed its attention on his speech, and the stimulus of the concussion released the inhibition and made him dumb. The man was cured by suggestion and psycho-analysis in three weeks. He recovered his power of speech, and the tremors left his body and limbs.

These cases will tend to illustrate the necessity of treatment in connection with this class of disorder. I heard it said recently by a well known physician : “ You cannot do much for them, unfortunately ; but, however, they get well in time.” This is not true ; it may be the case that they lose some of their external symptoms, but their mind has not been cured, and mental disorders will tend to occur if they are not carefully watched.

The necessity of understanding physiological psychology is increasing every day. Hospitals have been established for the soldier and officer for the treatment of hysterical disorders, but hysterical disorders are not only met with in war. They occur, unfortunately, in our daily life. There is an urgent need for the establishment of centres where patients could be seen and treated who are on the border line of mental disease for people who, in their own words, are “ feeling queer.” There is at present no treatment given to them, and many of these cases are not recognised in their early stages until they become so pronounced that they are sent to a private home or lunatic asylum. The medical student and ordinary practitioner have little knowledge of psychiatry and its application to medicine. At present the student only sees mental disease in its very advanced form, and the patient and lecture tends more to amuse than to instruct. The time will come, undoubtedly, when psychotherapy will be taught along with the other branches of medicine and facilities given for research work in mental diseases, and let us hope that that time is not so far distant.