f. 1

[*FROM THE AUTHOR.*

REMARKS ON REPLIES BY TEACHERS

TO

QUESTIONS RESPECTING MENTAL FATIGUE.

[*Reprinted from the Journ. of the Anthrop. Inst., November*, 1888.]

BY

FRANCIS GALTON, F.R.S.,

President of the Anthropological Institute.

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS
2/4/1/28

LONDON:

HARRISON AND SONS, ST. MARTIN'S LANE,

Printers in Ordinary to Her Majesty

1888.

f. 2

REMARKS ON REPLIES BY TEACHERS

TO

QUESTIONS RESPECTING MENTAL FATIGUE.

[*Reprinted from the Journ. of the Anthrop. Inst., November*, 1888.]

BY

FRANCIS GALTON, F.R.S.,
President of the Anthropological Institute.

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS
183

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.

1888.

f. 3r

UNIVERSITY COLLEGE LONDON
GALTON
PAPERS

Remarks *on* Replies *by* Teachers *to* Questions respecting Mental Fatigue.

By Francis Galton, F.R.S., President.

The question of over fatigue of the brain in schools was discussed some months ago with much heat, and the arguments on either side were supported by experiences that so flatly contradicted each other, as to make it difficult to arrive at just conclusions. After the heat of discussion had somewhat cooled down, it happened that I was asked to occupy the chair at a meeting of the Educational Section of the Teachers' Guild, and while doing so I was much impressed by the eager and sustained attention of the large audience to the memoir read on that evening. It occurred to me that the Teachers' Guild might become a powerful instrument for the solution of statistical problems, if the interest of its intelligent members could be excited in inquiries bearing on Education, and if their good will and confidence could be gained. I determined to make a trial, and selected questions bearing on fatigue for the purpose. The Council of the Guild kindly assisted me by circulating my questions, together with a covering letter from their Vice-Chairman, Dr. Morse. The replies to those questions form the basis of the following remarks. Let me say at once, that I was somewhat disappointed in respect to the number and fullness of the replies—so much so, that I long hesitated to publish anything before supplementing them with other materials, to be gained gradually through my own observation, but having much else on hand, it seemed on the whole best to work off this matter at once, without admixture. I have 116 replies from teachers, many of large experience, concerning both themselves and their pupils, and as this is just sufficient to deserve a separate discussion, I shall not travel beyond the bounds of what may be called my brief, I will not enter upon other materials, and barely into the psycho-physics of fatigue, but shall merely set forward in an orderly way the statements contained in the 116 replies.

The objects of my questions were first to determine the signs and effects of incipient fatigue in as *measureable* a form as possible; for it is obviously most desirable to know what the tests of fatigue should be, in consequence of the contradictory opinions above alluded to. There ought to be no room for doubt as to whether the pupils in a particular school or class, and at a particular time, were or were not over fatigued. Secondly, I wished to hear from the teachers whether they had themselves

ever broken down from over work, and what their own experiences might be concerning their pupils and friends. The actual questions are subjoined: numbers 1, 2, and 3 regard the person addressed; 4, 5, 6, regard their pupils and acquaintances.

1. What particular mental work can you perform easily, when your mind is fresh, that you find difficult or impossible when your mind is somewhat fatigued? 2. Has illness, due solely to mental overwork, independent of domestic anxiety and worry ever incapacitated you for more than a month at a time from ordinary school work? If so, give dates and symptoms. Do you consider your present health to be in any way affected by that illness? 3. Has experience discovered to you any warning signs, bodily or mental, distinct or obscure, of the imminent approach of mental fatigue, other than the growing sense of becoming fatigued? If so describe them. 4. What particular intellectual work do you find your pupils perform with ease when their minds are fresh, in which they fail more or less when they are mentally fatigued, even though they are still interested in their work? 5. Have you known cases of more or less serious prostration from mental overwork, as distinguished from the effects of domestic or other anxiety? If so, give initials and dates, and a very brief notice of the severity and duration of the illness? 6. Has experience discovered to you any warning signs of imminent mental fatigue among over zealous pupils?

The upshot of the replies to the questions is as follows:—

General Aspect.—Experienced teachers place most dependence on the general aspect of their classes, due to a variety of small indications, such as jaded expression and abnormal skin colour. They more especially speak of a strange look in the eye, which is variously described as dazed, weary, fixed, or lack lustre, as being a peculiarly characteristic indication that work should be slackened at once.

Nervous Irregularities.—Restlessness appears to be the commonest sign of partial fatigue: that is, of the attention being wearied while the muscles are craving to be employed. I may here for one moment break my plan of not travelling beyond my brief by alluding to a short account I wrote in "Nature" three years ago, Vol. xxxii, p. 174, but signed only with my initials, entiled "Measure of Fidget," describing how I had succeeded in counting the varying rate of fidget of a section of a large audience during the reading of a wearisome memoir. I have since frequently tried this method; it is an amusing way of passing an otherwise dull evening, but in drawing conclusions from the number of movements the average age of the audience and their habits of thought have to be taken into account. Children are extraordinary mobile, and those adults who are little accustomed

to concentrate their attention, are rarely still except when spell-bound by eloquence. On the other hand I have frequently noticed at meetings of the Royal Society, that as many of the persons present as I could hold in a glance, were all as rigid as statutary for many seconds together. Yawning and lolling are common among tired children, and twitchings and grimaces, which in serious cases culminate in St. Vitus' dance. Here are some extracts from the various replies.

1. Sudden muscular movements. 2. Grimaces, frowning, or compression of the lips are marked signs. 3. The fingers sometimes twitch and the whole nervous system seems affected. 4. Twitching of the face. 5. Twitching, blinking the eyes. 6. Fluttering of the eyelids. 7. Tendency to nervous laughter or movements. One correspondent has fits of sneezing in the early morning when he has been fatigued over night.

General unsteadiness of muscular co-ordination is shown by bad and shaky handwriting: this is sometimes specifically mentioned, but more often implied by such phrases as—8. Careless writing; or, 9. "Failure in all work requiring neatness." 10. Sometimes a loss of power to continue writing, the pen going crooked, &c. Fatigue is also very frequently indicated by disordered utterance as—11. Tendency to stumble over words when speaking. 12. Refusal of the tongue to obey the will, so that in speaking or reading I substitute one word for another.

Irregularity of nervous action is further shown by conditions of pallor or of flushings in the face. They sometimes alternate; testifying to a depression of general nerve power, combined with morbid excitability. Allusions to abnormal skin colour are frequent in the replies. One teacher goes so far as to lay particular stress on the colour of the tips of the ears in deciding whether and in what way the girls of her class are suffering. If the tips are white, flaccid, and drooping she concludes the girls are thoroughly weary in mind. If they are relaxed but purplish, she concludes that they are "tired not with study but from struggling with their nerves, which the average school girl of 14 or 15 very rarely has completely under control."

Headaches.—The frequent occurrence of headaches in varied forms and in every degree of severity may be accepted as a matter of course. Similarly as regards cold feet, faintness and actual faintings. Sleeplessness in a very serious degree is another well-known sign; much more rarely somnolence. Grinding the teeth at night and talking in the sleep are frequently mentioned; somnambulism occasionally so. I do not propose to enter into details respecting any of the matters just mentioned, as they are all of them well known signs of over fatigue. It may, however, perhaps interest the meeting to see

a drawing I hold in my hand made in sleep not many weeks ago, by a young friend and connection of my own, who was studying rather too hard for a Government examination. He awoke in the night, and found himself in his nightgown, sitting at his table with the gas burning and with this grotesque sketch of an elephant's head and of some other animals just completed. The ink was still wet. He had not the slightest recollection of anything previous to the act of awakening, but there had been conversation before he went to bed that probably suggested the sketch.

Disposition.—Irritability is perhaps the commonest sign of incipient fatigue. My correspondents freely acknowledge it to be so with themselves and it is very easily noticed among their pupils, who become cross and peevish when tired. I shall not enter further into this, as the fact is a familiar one; it is also well-known that the nerves of sensitive people becomes so irritable by overwork as to be painfully jarred by what they wholly disregard when well, such as the ticking of clocks and the rattle of the street. A most pitiable amount of suffering is disclosed in these replies, due to nervous irritability. Much is said of the gloomy way of looking at life, that is brought on by overwork; of the sense of incapacity, of magnifying trifles, and of dread of society. Irritability is sometimes accompanied by a notable amount of ordinary excitability expressed by such remarks as—1. I get nervous and start at noises. 2. I start sometimes at a sudden noise or movement in the room.

It is, I need hardly say, known by experiment, that both the quickness and the magnitude of the reaction to any stimulus is greatly affected by fatigue.

There is an experiment, not so well known as it should be, that after a class had practice in performing it, can be repeated at any time in a few seconds, which gives an excellent measure of the varying amount of reaction time. The class take hands all round, the teacher being included in the circle, a watch with a seconds hand lies on the table before him. All the pupils shut their eyes. When the seconds hand of the watch comes over a division the teacher gives a squeeze with his left hand to the right hand of the pupil next to him. That pupil forthwith with his left hand squeezes the right hand of the next pupil, and so on. Thus the squeeze travels round the class and is finally received by the right hand of the teacher, who then records the elapsed time since he started it; or he may let it make many circuits before he does so. This interval divided by the numbers of pupils in the class and by the number of circuits, gives the average reaction time of each pupil. The squeeze takes usually about a second of time to pass through

f. 5r

each dozen or fifteen persons. We should expect to find uniformity in successive experiments when the pupils are fresh; irregularity and prevalent delay when they are tired. I wish that teachers would often try this simple, amusing, and attractive experiment, and when they have assured themselves that their class enters into its performance with interest and curiosity, they might begin to make careful records at different periods of the day and see whether it admits of being used as a test of incipient fatigue. I should be exceedingly glad to receive accounts of their experiences. Deception must of course be guarded against.

Senses.—The frequency with which serious alteration in the power of hearing and of seeing is mentioned, and the feelings sometimes of intense sensitivity and sometimes of numbness, show that the delicacy of the senses is markedly affected by fatigue.

Hearing is often heightened in keenness, sometimes it is dulled. It is heightened in those numerous cases of irritability of which I have spoken, when the tired brain becomes almost maddened by an organ grinder. It is temporarily paralysed in others. The following is a mixed case:—1. My hearing had never been very acute, and I think the first symptom of fatigue is a feeling of deafness, but at the same time that I cannot hear the voices I want to hear, the outside noises of traffic, bells, &c., become intolerable. Other cases of deafness from fatigue are—2. Inability to hear in school without a painful effort. 3. Increased deafness.

Vision is greatly affected by over fatigue, not only owing to the strain upon the eyes from much reading in a bad light, but apparently through more deeply-seated causes as well. It is difficult otherwise to account for the following interesting case in which colour-blindness was brought on by fatigue and disappeared after rest. It has much physiological interest and well deserves being placed on record. The lady allows me to mention her name for the sake of authenticity. She is Miss J. Beckett, Girls' Grammar School, Ripon.

"After several hard hours of continuous study I have been subject to attacks of colour-blindness, which leave me after resting. The first time I noticed that I was not able to distinguish one colour from another, was when I was reading for the London Matriculation years ago. I was at the same time etching for an American magazine and teaching most of the day. This lasted from Christmas to July, when I began to feel considerably worn out. One day I went to spend a few hours with a friend, and whilst there, began to paint some ivy leaves on a terra-cotta plaque. Imagine my distress when my friend told

me the leaves were orange instead of green. On my return I went into my study and to my astonishment, the curtains which were blue in colour looked a kind of dingy yellow. However in a few hours I was quite well. Towards the end of the year I was obliged to give up work on account of my health. I got well, and took up my work again, still subject to temporary colour-blindness when tired." In answer to further inquiries, she adds: "I do not remember whether I have any difficulty in recalling colours when tired. From a little child I have been particularly fond of them, and can readily paint flowers, foliage, and neutral tints from memory."

The frequency and severity with which the sight is affected by fatigue is sufficiently shown by the following extracts:—

1. The eyes fail first. Sometimes after hurrying to a lesson, on my arrival I could not see a single note on the page of music for a few minutes. After writing and playing long, everything goes black or black spots dance up and down. 2. A time of great excitement or worry will so affect my sight that for about half-an-hour at a time, I can see nothing clearly. The outline of everything is deficient in some part, so that I only see half of a thing at a time. There seems to be a bright wheel of light whizzing in the corner of one or the other eye.

3. At first the lines of the page become indistinct, then at intervals they appear to vibrate; finally they merge into one mass.

4. The words appear to rise from the paper and frequently a double row of words are visible.

5. Lights and after images are distinct before my eye.

6. A confusion in the lettering of mathematical diagrams is sometimes an early symptom of fatigue among my pupils.

As regards sensations in the eye itself, beside such remarks as—7. A dazzling and burning sensation in the eye, the following is a case of an affection of the eye being subordinate to that of the brain, rather than *vice versâ*.

8. A nervous sensation in the eyes as though the eyeballs were loose in my head, and would fall which ever way the head is inclined. The sensation is worse on lying down. I am somewhat short-sighted and wear glasses, but only feel this disagreeable sensation when mentally weary, not necessarily through over-reading.

Memory.—A very common and early symptom of fatigue is failure of memory, using that word in the allied senses of recalling ideas at will, or else of former ideas presenting themselves readily by association, or else of the sure association of muscular movements engaged in utterance, with the idea of the words intended to be uttered. I have made extracts of no less

f. 6r

than twenty-five cases of failure of memory, out of which I will select half-a-dozen.

1. My first indication of mental failure is an inability to spell common words; my second, an omission of words in writing; my third, sudden forgetfulness of what I am actually saying. 2. Tendency to forget the meaning of words in a foreign language which are usually well known or have been met with quite recently. Tendency to make stupid blunders in subjects in which, when the mind is in full vigour, it is accurate without effort. Simple and obvious mistakes are increased twofold in number, and that throughout the class. 3. Through days and weeks together, the utterance of wrong words or sentences, not intended or desired to be spoken, and the writing of wrong words. 4. Tendency to stumble over words in speaking, and to misplace letters in writing, generally putting them too soon as "Wesday" for "Wednesday." 5. Want of power of calling at will to memory, names and little matters connected with every day life. 6. Some of the pupils never spell correctly when tired.

Arithmetic and Mathematics.—The studies that are the first to fail under fatigue differ in different individuals, but in the majority of cases those of arithmetic and elementary mathematics go soonest. Though many of the 116 replies come from teachers who have little, if anything, to do with those subjects, no less than forty-seven specifically mention them. For example:—

1. The merely mechanical processes of arithmetic become bewildering at the end of a day in which I have been particularly engrossed with school work.

2. Arithmetic and algebra become impossible when fatigued, not as being disagreeable or painful, but because I then blunder so much that it is hardly any use attempting them.

3. Another correspondent speaks of the impossibility when fatigued of doing work that requires both accuracy of detail and a certain force of will to fix the attention, such as arithmetic.

4. Speaks of the difficulty to tired boys of working out any *common sense* problem in arithmetic.

Though very many similar answers could be quoted in corroboration of these, there are two that tell in an opposite direction. They are—

5. Whenever my mind is wearied, it affords me a certain amount of relief to do some work which involves the solving of arithmetical and algebraical problems, and by preference such as call for the use of logarithms or of the slide rule.

6. I find accounts a great rest when I cannot exert my mind usefully in any other way.

I may be permitted again to break my rule by adding a case

from my own knowledge of a very distinguished man, now deceased, who having always found repose in his favourite mathematics when he was fagged and worried by multifarious duties, naively recommended the same remedy to a friend whose brain had so broken down for a time, that he shrank from the least mental exertion as from a fatal danger.

Languages.—A difficulty in translating is another of the noticeable effects of incipient fatigue, and is partly due to the lapses of memory already spoken of.

1. In translating, words and phrases do not occur readily to the mind.

2. Translation into or out of a foreign language with which I am not very familiar.

3. I have occasionally lost the power of speaking German when fatigued, though when in my ordinary condition I speak it without conscious effort.

The failure to translate *well* is due of course to much more than the simple failure of memory in small things and depends on the loss of power of grasp, and on depressed mental vigour generally. The following is an instructive case :—

When I taught young boys of ages 8 to 13, all day, I took arithmetic and Latin in the morning, and English reading, geography, &c., in the afternoon. On some occasions the Latin lesson got put off till the afternoon, and I was surprised to find that lesson, which was always a successful one in the morning, failed entirely in the afternoon. The boys wished to learn but could not. Their ordinary work, which made less demand on the intellect, they did in the afternoon well enough.

This and such like cases fall more properly in the next division.

Failure of Mental Grasp.—The evidences that the fatigued mind is unable to work up to its normal standard, and that it wastes itself in futile exertion, are very numerous. They are such as :—

1. Failure of ability to grasp the meaning of even simple things.

2. Failure of the *portative* memory. In reading complete inability to take in the matter whilst mechanically scanning the page. A curious incapacity to count the cups when serving tea.

3. Reading sentences without recognition of what was read.

4. Confusion alternating with excessive clearness of thought.

5. Tendency of thoughts to wander. Failure in pupils to grasp the meaning of what is said to them quickly and fully.

6. Before the actual sense of fatigue is distinctly felt, I am

F. 7c

conscious of a want of power to grasp ideas, and of an incapacity for conveying them clearly.

7. Inability to read the "Journal of Education."

8. Rapid disappearance of immediately preceding concepts, and hence difficulty in establishing connections between paragraphs, as in writing a Review article.

9. Tendency to *use long words.* (This strikes me as a very suggestive reply).

10. Any book in which the language is wanting in ease and simplicity, though its subject may be familiar or easily understood.

In short, to use a common and vigorous phrase, the mind ceases to *bite,* when it is fatigued.

Failure of Energy.—It requires no evidence to corroborate the well known fact that energy fails as fatigue increases. New subjects are distasteful; teaching dullards becomes almost an impossibility. Sustained effort, vigorous inspection, quick decision—all are impossible.

Possibility of Tests of Incipient Fatigue.—The replies I have received do not contain any distinct proposition of tests of incipient mental fatigue, and I am myself far too ignorant of the practice of education to venture to formulate any. On the other hand, the replies are not deficient in indications of what such tests might be directed to ascertain. They are principally as follows:—

1. The length of time during which neatness of execution can be sustained in performing a prolonged task.

2. Promptness and sureness of memory in simple things.

3. Common sense arithmetical problems.

4. Reaction time.

The measure of fatigue is inversely the measure of endurance, and this strikes me as being a faculty that well deserves investigation. Under the strain and exhausting calls of modern civilized life, the power of endurance is rising continually in importance. Men and women have now a-days to act rapidly and for many hours, and not only to act exceptionally well. It therefore seems very reasonable that teachers should direct their attention to some fair way of appraising the relative power of endurance among their pupils. It is of course incidentally discovered in the ordinary course of tuition, but one would like to see appropriate tests directly applied to determine it, and such as would show at any time in a definite and unmistakeable manner whether the minds of pupils were fagged or not.

Breaking Down.—I now come to the evidence given in these replies respecting the frequency with which both pupils and

teachers are found to "break down." There is an intelligible and very transparent tendency in not a few of the respondents to say that such a thing as overwork is impossible in their respective schools. Some of them protest so much and so extravagantly as to raise not a little suspicion. There are even a few who say they have never heard of a case of breaking down.

Taking all the replies together, I find that out of my 116 correspondents no less than 23 of them have at some period of their lives broken down, and that 21 of these have never wholly recovered the effects. There are six other cases of a less serious kind, some of them slight. In other words one out of five teachers has, so far as the evidence before me goes, been severely stricken. As to the cases well known to my correspondents, there is vagueness in some of the replies where the word "several," and the like, are used, to which I am quite unable to assign a numerical value, but 59 sad cases are specified in detail in answer to the question 5 : "Have you known cases of more or less serious prostration from mental overwork, as distinguished from the effects of domestic or other anxiety? If so, give initials and dates, and a very brief notice of the severity and duration of the illness."

In many other cases the writers express the difficulty they feel in distinguishing between worry and overwork. The latter is a consequence of the former, while the former often results from the gloom, anxiety, and sense of incapacity caused by the latter. It is a self regenerating circle of evil.

I draw two conclusions from the replies. The first is that the reason why mental fatigue leaves effects that are so much more serious than those of bodily fatigue is largely owing to the cause just mentioned. When a man is fatigued in body he has very similar symptoms to many of those mentioned above, but there is a great after difference. As soon as the bodily exertion has closed for the day, the man lies down and his muscles have rest; but when the mentally fatigued man lies down, his enemy continues to harass him during his weary hours of sleeplessness. He cannot quiet his thoughts and he wastes himself in a futile way.

The other conclusion is that breaks down usually occur amongst those who work by themselves, and not among pupils whose teachers keep a reasonable oversight. Over zealous pupils are rare, as many of my correspondents insist. But the danger is not so much at school, when the hours of study and those of play and exercise are fixed, as it is at the age when young persons are qualifying themselves for the profession of a teacher, and who have also to support themselves, and perhaps to endure domestic trials at the same time. Dull persons

F. 8

protect their own health of brain by refusing to overwork. It is among those who are zealous and eager, who have high aims and ideas, who know themselves to be mentally gifted, and are too generous to think much of their own health, that the most frequent victims of overwork are chiefly found.

UNIVERSITY COLLEGE LONDON
GALTON.
PAPERS

[*Reprinted from the Journal of the Anthropological Institute, November*, 1888.]

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane.

E. S. Galton

f. 11

[FROM THE AUTHOR.

5. Bertie Terrace
Leamington

REMARKS ON REPLIES BY TEACHERS

TO

QUESTIONS RESPECTING MENTAL FATIGUE.

[*Reprinted from the Journ. of the Anthrop. Inst., November*, 1888.]

BY

FRANCIS GALTON, F.R.S.,
President of the Anthropological Institute.

UNIVERSITY COLLEGE LONDON
GALTON PAPERS
2/11/1/28

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty

1888.

F. 12

REMARKS ON REPLIES BY TEACHERS

TO

QUESTIONS RESPECTING MENTAL FATIGUE.

[*Reprinted from the Journ. of the Anthrop. Inst., November*, 1888.]

BY

FRANCIS GALTON, F.R.S.,
President of the Anthropological Institute.

LONDON:
HARRISON AND SONS, ST. MARTIN'S LANE,
Printers in Ordinary to Her Majesty.

1888.

f. 13r

Remarks *on* Replies *by* Teachers *to* Questions respecting Mental Fatigue.

By Francis Galton, F.R.S., President.

The question of over fatigue of the brain in schools was discussed some months ago with much heat, and the arguments on either side were supported by experiences that so flatly contradicted each other, as to make it difficult to arrive at just conclusions. After the heat of discussion had somewhat cooled down, it happened that I was asked to occupy the chair at a meeting of the Educational Section of the Teachers' Guild, and while doing so I was much impressed by the eager and sustained attention of the large audience to the memoir read on that evening. It occurred to me that the Teachers' Guild might become a powerful instrument for the solution of statistical problems, if the interest of its intelligent members could be excited in inquiries bearing on Education, and if their good will and confidence could be gained. I determined to make a trial, and selected questions bearing on fatigue for the purpose. The Council of the Guild kindly assisted me by circulating my questions, together with a covering letter from their Vice-Chairman, Dr. Morse. The replies to those questions form the basis of the following remarks. Let me say at once, that I was somewhat disappointed in respect to the number and fullness of the replies—so much so, that I long hesitated to publish anything before supplementing them with other materials, to be gained gradually through my own observation, but having much else on hand, it seemed on the whole best to work off this matter at once, without admixture. I have 116 replies from teachers, many of large experience, concerning both themselves and their pupils, and as this is just sufficient to deserve a separate discussion, I shall not travel beyond the bounds of what may be called my brief, I will not enter upon other materials, and barely into the psycho-physics of fatigue, but shall merely set forward in an orderly way the statements contained in the 116 replies.

The objects of my questions were first to determine the signs and effects of incipient fatigue in as *measureable* a form as possible; for it is obviously most desirable to know what the tests of fatigue should be, in consequence of the contradictory opinions above alluded to. There ought to be no room for doubt as to whether the pupils in a particular school or class, and at a particular time, were or were not over fatigued. Secondly, I wished to hear from the teachers whether they had themselves

ever broken down from over work, and what their own experiences might be concerning their pupils and friends. The actual questions are subjoined: numbers 1, 2, and 3 regard the person addressed; 4, 5, 6, regard their pupils and acquaintances.

1. What particular mental work can you perform easily, when your mind is fresh, that you find difficult or impossible when your mind is somewhat fatigued? 2. Has illness, due solely to mental overwork, independent of domestic anxiety and worry ever incapacitated you for more than a month at a time from ordinary school work? If so, give dates and symptoms. Do you consider your present health to be in any way affected by that illness? 3. Has experience discovered to you any warning signs, bodily or mental, distinct or obscure, of the imminent approach of mental fatigue, other than the growing sense of becoming fatigued? If so describe them. 4. What particular intellectual work do you find your pupils perform with ease when their minds are fresh, in which they fail more or less when they are mentally fatigued, even though they are still interested in their work? 5. Have you known cases of more or less serious prostration from mental overwork, as distinguished from the effects of domestic or other anxiety? If so, give initials and dates, and a very brief notice of the severity and duration of the illness? 6. Has experience discovered to you any warning signs of imminent mental fatigue among over zealous pupils?

The upshot of the replies to the questions is as follows:—

General Aspect.—Experienced teachers place most dependence on the general aspect of their classes, due to a variety of small indications, such as jaded expression and abnormal skin colour. They more especially speak of a strange look in the eye, which is variously described as dazed, weary, fixed, or lack lustre, as being a peculiarly characteristic indication that work should be slackened at once.

Nervous Irregularities.—Restlessness appears to be the commonest sign of partial fatigue: that is, of the attention being wearied while the muscles are craving to be employed. I may here for one moment break my plan of not travelling beyond my brief by alluding to a short account I wrote in "Nature" three years ago, Vol. xxxii, p. 174, but signed only with my initials, entiled "Measure of Fidget," describing how I had succeeded in counting the varying rate of fidget of a section of a large audience during the reading of a wearisome memoir. I have since frequently tried this method; it is an amusing way of passing an otherwise dull evening, but in drawing conclusions from the number of movements the average age of the audience and their habits of thought have to be taken into account. Children are extraordinary mobile, and those adults who are little accustomed

f. 14 r

LLEGE LONDON
TON
ERS

to concentrate their attention, are rarely still except when spell-bound by eloquence. On the other hand I have frequently noticed at meetings of the Royal Society, that as many of the persons present as I could hold in a glance, were all as rigid as statutary for many seconds together. Yawning and lolling are common among tired children, and twitchings and grimaces, which in serious cases culminate in St. Vitus' dance. Here are some extracts from the various replies.

1. Sudden muscular movements. 2. Grimaces, frowning, or compression of the lips are marked signs. 3. The fingers sometimes twitch and the whole nervous system seems affected. 4. Twitching of the face. 5. Twitching, blinking the eyes. 6. Fluttering of the eyelids. 7. Tendency to nervous laughter or movements. One correspondent has fits of sneezing in the early morning when he has been fatigued over night.

General unsteadiness of muscular co-ordination is shown by bad and shaky handwriting: this is sometimes specifically mentioned, but more often implied by such phrases as—8. Careless writing; or, 9. "Failure in all work requiring neatness." 10. Sometimes a loss of power to continue writing, the pen going crooked, &c. Fatigue is also very frequently indicated by disordered utterance as—11. Tendency to stumble over words when speaking. 12. Refusal of the tongue to obey the will, so that in speaking or reading I substitute one word for another.

Irregularity of nervous action is further shown by conditions of pallor or of flushings in the face. They sometimes alternate; testifying to a depression of general nerve power, combined with morbid excitability. Allusions to abnormal skin colour are frequent in the replies. One teacher goes so far as to lay particular stress on the colour of the tips of the ears in deciding whether and in what way the girls of her class are suffering. If the tips are white, flaccid, and drooping she concludes the girls are thoroughly weary in mind. If they are relaxed but purplish, she concludes that they are "tired not with study but from struggling with their nerves, which the average school girl of 14 or 15 very rarely has completely under control."

Headaches.—The frequent occurrence of headaches in varied forms and in every degree of severity may be accepted as a matter of course. Similarly as regards cold feet, faintness and actual faintings. Sleeplessness in a very serious degree is another well-known sign; much more rarely somnolence. Grinding the teeth at night and talking in the sleep are frequently mentioned; somnambulism occasionally so. I do not propose to enter into details respecting any of the matters just mentioned, as they are all of them well known signs of over fatigue. It may, however, perhaps interest the meeting to see

a drawing I hold in my hand made in sleep not many weeks ago, by a young friend and connection of my own, who was studying rather too hard for a Government examination. He awoke in the night, and found himself in his nightgown, sitting at his table with the gas burning and with this grotesque sketch of an elephant's head and of some other animals just completed. The ink was still wet. He had not the slightest recollection of anything previous to the act of awakening, but there had been conversation before he went to bed that probably suggested the sketch.

Disposition.—Irritability is perhaps the commonest sign of incipient fatigue. My correspondents freely acknowledge it to be so with themselves and it is very easily noticed among their pupils, who become cross and peevish when tired. I shall not enter further into this, as the fact is a familiar one; it is also well-known that the nerves of sensitive people becomes so irritable by overwork as to be painfully jarred by what they wholly disregard when well, such as the ticking of clocks and the rattle of the street. A most pitiable amount of suffering is disclosed in these replies, due to nervous irritability. Much is said of the gloomy way of looking at life, that is brought on by overwork; of the sense of incapacity, of magnifying trifles, and of dread of society. Irritability is sometimes accompanied by a notable amount of ordinary excitability expressed by such remarks as—1. I get nervous and start at noises. 2. I start sometimes at a sudden noise or movement in the room.

It is, I need hardly say, known by experiment, that both the quickness and the magnitude of the reaction to any stimulus is greatly affected by fatigue.

There is an experiment, not so well known as it should be, that after a class had practice in performing it, can be repeated at any time in a few seconds, which gives an excellent measure of the varying amount of reaction time. The class take hands all round, the teacher being included in the circle, a watch with a seconds hand lies on the table before him. All the pupils shut their eyes. When the seconds hand of the watch comes over a division the teacher gives a squeeze with his left hand to the right hand of the pupil next to him. That pupil forthwith with his left hand squeezes the right hand of the next pupil, and so on. Thus the squeeze travels round the class and is finally received by the right hand of the teacher, who then records the elapsed time since he started it; or he may let it make many circuits before he does so. This interval divided by the numbers of pupils in the class and by the number of circuits, gives the average reaction time of each pupil. The squeeze takes usually about a second of time to pass through

f. 15r

each dozen or fifteen persons. We should expect to find uniformity in successive experiments when the pupils are fresh; irregularity and prevalent delay when they are tired. I wish that teachers would often try this simple, amusing, and attractive experiment, and when they have assured themselves that their class enters into its performance with interest and curiosity, they might begin to make careful records at different periods of the day and see whether it admits of being used as a test of incipient fatigue. I should be exceedingly glad to receive accounts of their experiences. Deception must of course be guarded against.

Senses.—The frequency with which serious alteration in the power of hearing and of seeing is mentioned, and the feelings sometimes of intense sensitivity and sometimes of numbness, show that the delicacy of the senses is markedly affected by fatigue.

Hearing is often heightened in keenness, sometimes it is dulled. It is heightened in those numerous cases of irritability of which I have spoken, when the tired brain becomes almost maddened by an organ grinder. It is temporarily paralysed in others. The following is a mixed case:—1. My hearing had never been very acute, and I think the first symptom of fatigue is a feeling of deafness, but at the same time that I cannot hear the voices I want to hear, the outside noises of traffic, bells, &c., become intolerable. Other cases of deafness from fatigue are—2. Inability to hear in school without a painful effort. 3. Increased deafness.

Vision is greatly affected by over fatigue, not only owing to the strain upon the eyes from much reading in a bad light, but apparently through more deeply-seated causes as well. It is difficult otherwise to account for the following interesting case in which colour-blindness was brought on by fatigue and disappeared after rest. It has much physiological interest and well deserves being placed on record. The lady allows me to mention her name for the sake of authenticity. She is Miss J. Beckett, Girls' Grammar School, Ripon.

"After several hard hours of continuous study I have been subject to attacks of colour-blindness, which leave me after resting. The first time I noticed that I was not able to distinguish one colour from another, was when I was reading for the London Matriculation years ago. I was at the same time etching for an American magazine and teaching most of the day. This lasted from Christmas to July, when I began to feel considerably worn out. One day I went to spend a few hours with a friend, and whilst there, began to paint some ivy leaves on a terra-cotta plaque. Imagine my distress when my friend told

me the leaves were orange instead of green. On my return I went into my study and to my astonishment, the curtains which were blue in colour looked a kind of dingy yellow. However in a few hours I was quite well. Towards the end of the year I was obliged to give up work on account of my health. I got well, and took up my work again, still subject to temporary colour-blindness when tired." In answer to further inquiries, she adds: "I do not remember whether I have any difficulty in recalling colours when tired. From a little child I have been particularly fond of them, and can readily paint flowers, foliage, and neutral tints from memory."

The frequency and severity with which the sight is affected by fatigue is sufficiently shown by the following extracts:—

1. The eyes fail first. Sometimes after hurrying to a lesson, on my arrival I could not see a single note on the page of music for a few minutes. After writing and playing long, everything goes black or black spots dance up and down. 2. A time of great excitement or worry will so affect my sight that for about half-an-hour at a time, I can see nothing clearly. The outline of everything is deficient in some part, so that I only see half of a thing at a time. There seems to be a bright wheel of light whizzing in the corner of one or the other eye.

3. At first the lines of the page become indistinct, then at intervals they appear to vibrate; finally they merge into one mass.

4. The words appear to rise from the paper and frequently a double row of words are visible.

5. Lights and after images are distinct before my eye.

6. A confusion in the lettering of mathematical diagrams is sometimes an early symptom of fatigue among my pupils.

As regards sensations in the eye itself, beside such remarks as—7. A dazzling and burning sensation in the eye, the following is a case of an affection of the eye being subordinate to that of the brain, rather than *vice versâ*.

8. A nervous sensation in the eyes as though the eyeballs were loose in my head, and would fall which ever way the head is inclined. The sensation is worse on lying down. I am somewhat short-sighted and wear glasses, but only feel this disagreeable sensation when mentally weary, not necessarily through over-reading.

Memory.—A very common and early symptom of fatigue is failure of memory, using that word in the allied senses of recalling ideas at will, or else of former ideas presenting themselves readily by association, or else of the sure association of muscular movements engaged in utterance, with the idea of the words intended to be uttered. I have made extracts of no less

f. 16r

than twenty-five cases of failure of memory, out of which I will select half-a-dozen.

1. My first indication of mental failure is an inability to spell common words; my second, an omission of words in writing; my third, sudden forgetfulness of what I am actually saying. 2. Tendency to forget the meaning of words in a foreign language which are usually well known or have been met with quite recently. Tendency to make stupid blunders in subjects in which, when the mind is in full vigour, it is accurate without effort. Simple and obvious mistakes are increased twofold in number, and that throughout the class. 3. Through days and weeks together, the utterance of wrong words or sentences, not intended or desired to be spoken, and the writing of wrong words. 4. Tendency to stumble over words in speaking, and to misplace letters in writing, generally putting them too soon as "Wesday" for "Wednesday." 5. Want of power of calling at will to memory, names and little matters connected with every day life. 6. Some of the pupils never spell correctly when tired.

Arithmetic and Mathematics.—The studies that are the first to fail under fatigue differ in different individuals, but in the majority of cases those of arithmetic and elementary mathematics go soonest. Though many of the 116 replies come from teachers who have little, if anything, to do with those subjects, no less than forty-seven specifically mention them. For example:—

1. The merely mechanical processes of arithmetic become bewildering at the end of a day in which I have been particularly engrossed with school work.

2. Arithmetic and algebra become impossible when fatigued, not as being disagreeable or painful, but because I then blunder so much that it is hardly any use attempting them.

3. Another correspondent speaks of the impossibility when fatigued of doing work that requires both accuracy of detail and a certain force of will to fix the attention, such as arithmetic.

4. Speaks of the difficulty to tired boys of working out any *common sense* problem in arithmetic.

Though very many similar answers could be quoted in corroboration of these, there are two that tell in an opposite direction. They are—

5. Whenever my mind is wearied, it affords me a certain amount of relief to do some work which involves the solving of arithmetical and algebraical problems, and by preference such as call for the use of logarithms or of the slide rule.

6. I find accounts a great rest when I cannot exert my mind usefully in any other way.

I may be permitted again to break my rule by adding a case

from my own knowledge of a very distinguished man, now deceased, who having always found repose in his favourite mathematics when he was fagged and worried by multifarious duties, naively recommended the same remedy to a friend whose brain had so broken down for a time, that he shrank from the least mental exertion as from a fatal danger.

Languages.—A difficulty in translating is another of the noticeable effects of incipient fatigue, and is partly due to the lapses of memory already spoken of.

1. In translating, words and phrases do not occur readily to the mind.

2. Translation into or out of a foreign language with which I am not very familiar.

3. I have occasionally lost the power of speaking German when fatigued, though when in my ordinary condition I speak it without conscious effort.

The failure to translate *well* is due of course to much more than the simple failure of memory in small things and depends on the loss of power of grasp, and on depressed mental vigour generally. The following is an instructive case :—

When I taught young boys of ages 8 to 13, all day, I took arithmetic and Latin in the morning, and English reading, geography, &c., in the afternoon. On some occasions the Latin lesson got put off till the afternoon, and I was surprised to find that lesson, which was always a successful one in the morning, failed entirely in the afternoon. The boys wished to learn but could not. Their ordinary work, which made less demand on the intellect, they did in the afternoon well enough.

This and such like cases fall more properly in the next division.

Failure of Mental Grasp.—The evidences that the fatigued mind is unable to work up to its normal standard, and that it wastes itself in futile exertion, are very numerous. They are such as :—

1. Failure of ability to grasp the meaning of even simple things.

2. Failure of the *portative* memory. In reading complete inability to take in the matter whilst mechanically scanning the page. A curious incapacity to count the cups when serving tea.

3. Reading sentences without recognition of what was read.

4. Confusion alternating with excessive clearness of thought.

5. Tendency of thoughts to wander. Failure in pupils to grasp the meaning of what is said to them quickly and fully.

6. Before the actual sense of fatigue is distinctly felt, I am

f. 17r

conscious of a want of power to grasp ideas, and of an incapacity for conveying them clearly.

7. Inability to read the "Journal of Education."

8. Rapid disappearance of immediately preceding concepts, and hence difficulty in establishing connections between paragraphs, as in writing a Review article.

9. Tendency to *use long words.* (This strikes me as a very suggestive reply).

10. Any book in which the language is wanting in ease and simplicity, though its subject may be familiar or easily understood.

In short, to use a common and vigorous phrase, the mind ceases to *bite,* when it is fatigued.

Failure of Energy.—It requires no evidence to corroborate the well known fact that energy fails as fatigue increases. New subjects are distasteful; teaching dullards becomes almost an impossibility. Sustained effort, vigorous inspection, quick decision—all are impossible.

Possibility of Tests of Incipient Fatigue.—The replies I have received do not contain any distinct proposition of tests of incipient mental fatigue, and I am myself far too ignorant of the practice of education to venture to formulate any. On the other hand, the replies are not deficient in indications of what such tests might be directed to ascertain. They are principally as follows:—

1. The length of time during which neatness of execution can be sustained in performing a prolonged task.

2. Promptness and sureness of memory in simple things.

3. Common sense arithmetical problems.

4. Reaction time.

The measure of fatigue is inversely the measure of endurance, and this strikes me as being a faculty that well deserves investigation. Under the strain and exhausting calls of modern civilized life, the power of endurance is rising continually in importance. Men and women have now a-days to act rapidly and for many hours, and not only to act exceptionally well. It therefore seems very reasonable that teachers should direct their attention to some fair way of appraising the relative power of endurance among their pupils. It is of course incidentally discovered in the ordinary course of tuition, but one would like to see appropriate tests directly applied to determine it, and such as would show at any time in a definite and unmistakeable manner whether the minds of pupils were fagged or not.

Breaking Down.—I now come to the evidence given in these replies respecting the frequency with which both pupils and

teachers are found to "break down." There is an intelligible and very transparent tendency in not a few of the respondents to say that such a thing as overwork is impossible in their respective schools. Some of them protest so much and so extravagantly as to raise not a little suspicion. There are even a few who say they have never heard of a case of breaking down.

Taking all the replies together, I find that out of my 116 correspondents no less than 23 of them have at some period of their lives broken down, and that 21 of these have never wholly recovered the effects. There are six other cases of a less serious kind, some of them slight. In other words one out of five teachers has, so far as the evidence before me goes, been severely stricken. As to the cases well known to my correspondents, there is vagueness in some of the replies where the word "several," and the like, are used, to which I am quite unable to assign a numerical value, but 59 sad cases are specified in detail in answer to the question 5 : "Have you known cases of more or less serious prostration from mental overwork, as distinguished from the effects of domestic or other anxiety? If so, give initials and dates, and a very brief notice of the severity and duration of the illness."

In many other cases the writers express the difficulty they feel in distinguishing between worry and overwork. The latter is a consequence of the former, while the former often results from the gloom, anxiety, and sense of incapacity caused by the latter. It is a self regenerating circle of evil.

I draw two conclusions from the replies. The first is that the reason why mental fatigue leaves effects that are so much more serious than those of bodily fatigue is largely owing to the cause just mentioned. When a man is fatigued in body he has very similar symptoms to many of those mentioned above, but there is a great after difference. As soon as the bodily exertion has closed for the day, the man lies down and his muscles have rest; but when the mentally fatigued man lies down, his enemy continues to harass him during his weary hours of sleeplessness. He cannot quiet his thoughts and he wastes himself in a futile way.

The other conclusion is that breaks down usually occur amongst those who work by themselves, and not among pupils whose teachers keep a reasonable oversight. Over zealous pupils are rare, as many of my correspondents insist. But the danger is not so much at school, when the hours of study and those of play and exercise are fixed, as it is at the age when young persons are qualifying themselves for the profession of a teacher, and who have also to support themselves, and perhaps to endure domestic trials at the same time. Dull persons

f. 18

protect their own health of brain by refusing to overwork. It is among those who are zealous and eager, who have high aims and ideas, who know themselves to be mentally gifted, and are too generous to think much of their own health, that the most frequent victims of overwork are chiefly found.

[*Reprinted from the Journal of the Anthropological Institute, November*, 1888.]

Harrison and Sons, Printers in Ordinary to Her Majesty, St. Martin's Lane.