current of 330 volts was turned on, and the dog was killed. Further experiments were prevented by an agent of the Society for the Prevention of Cruelty to Animals. This was unfortunate, as the result was distinctly unfair to the alternating side of the question, since a dog that had been subjected to a 1,000-volt continuous current was hardly in condition to stand very much more, no matter under what form the shock came. On Aug. 3, however, the experiments were repeated on a number of dogs, before Dr. Cyrus Edson and a number of physicians and electricians. The main results are embodied in the letter to *Science* published Aug. 10. In this letter three cases are mentioned, in each of which a strong and healthy dog was killed by alternating currents whose voltage varied from 340.5 (the highest) to 234 (the lowest). In some further experiments given by Mr. Brown in the *Electrical World*, a number of dogs were killed by alternating and by continuous currents. The maximum alternating-current voltage that was taken without death resulting was 500; continuous-current, 1,420 volts. Minimum alternating current that caused death was at 188 volts; continuous current, 800 volts. The physicians present expressed the opinion that a current which killed a dog would be fatal to a man under similar conditions.

If these experiments were conclusive, they would mean that alternating currents would destroy life at less than half the voltage that would make continuous currents dangerous. This is partly due to the fact, that when we measure alternating electro-motive forces by a Cardew voltmeter, such as was used in Mr. Brown's experiments, we measure the mean, not the maximum, electro-motive force; which last is, very roughly, half again as much. Still, as we always consider the mean electro-motive force, and as the alternating system uses a mean electro-motive force of 1,000 or 2,000 volts, whichever it may happen to be, we must drop the distinction between mean and maximum, or we must carry it into our practical work. Both these experiments are contradicted by the statements of various people that they have taken alternating electromotive forces as high as 1,000 volts without inconvenience. Still, until these statements are more definite as to the conditions under which the shocks were taken, we may consider that Mr. Brown has the upper hand.

But, whatever may be thought of Mr. Brown's experiments on dogs, they add to the evidence pointing to the fact that an alternating current of 1,000 volts electro-motive force would be fatal. Such a pressure is far above the limit set by M. d'Arsonval, and few fair-minded persons will doubt its danger. This being the case, the question arises, Should a system using such a pressure be allowed for house-to-house distribution in crowded cities? Under certain circumstances, this could be safely done; under others it could not. If the wires can be taken over head, and if the converters may be placed on poles in front of the houses, the low-pressure secondary circuit alone entering the house, then the system, if properly installed, is reasonably safe, and should not be objected to on that score. If it is necessary, on the other hand, to put the wires under ground, and to bring them into houses to supply converters in the cellar, say, then the system is not safe, nor will it be economical; for the trouble and expense of keeping a network of high-potential mains in order, leaving out the danger, will take from the economy and popularity of the system. The rational and safe way of using the system, in a city where overhead wires are not allowed, is to have a number of sub-stations in the district to be lighted, to which the high-potential mains are taken, and from which current is distributed to the houses at a low potential. On this latter plan, there is no reason that the system should not be used in New York or anywhere else. The high-potential conductors are less dangerous than the arc-light circuits; for they are tapped at fewer places, and the current is not taken into any house at a pressure high enough to cause death. It is, in fact, the only safe method of alternating-current distribution under ground. We hope that it will be tried, and that it will succeed.

A NEW ELECTRO-DYNAMOMETER. — M. Pellat has devised an electro-dynamometer which seems sensitive, and whose constant may be determined with accuracy from measurements. It consists of two cylindrical coils of wire, one within the other. The axis of the longer and larger one is horizontal, that of the smaller is vertical, and the two axes intersect at their middle points. If, now, a current be sent through the coils, — the outer one being fixed, the inner movable, — the axis of the latter will tend to place itself parallel to that of the former. The smaller coil is at one end of a scale-beam, and its tendency to move is balanced by weights added to the pan at the other end. The current is calculated from the weight in the pan and the dimensions of the two coils, the latter being in the form of a constant. The current is conducted to the inner coil by two silver wires joining the support with terminals on the scale-beam, to which the ends of the coil are taken. The two most difficult measurements that have to be made are the diameter of the cylindrical coils and the distance apart of the turns of wire. The former, M. Pellat states, can be made with an accuracy of 1 part in 5,000; the latter, within 1 in 3,000; and, as we measure the square of the current, the last error would only appear as 1 in 6,000 in the result. In discussing all the sources of error, M. Pellat reaches the conclusion that the results of measurements are correct to at least 1 part in 2,000. The currents that can be measured are not greater than .6 or .8 of an ampère, the difficulty lying in the fact that in getting the current to the inner coil very fine wires must be used in connecting the stationary with the movable parts, otherwise the sensitiveness will be decreased. To allow for the effect of the earth's magnetism, the current is sent first in one direction, then in the other. The difference in the weighings is due to the magnetism of the earth. In calculating the current from a weighing, we have very simply $i = A \sqrt{p}$, where A is a constant calculated from the dimensions of the instrument, and p is the weight in the scale-pan. The sensitiveness of the instrument allows measurements to be taken within 1 in 10,000. M. Pellat proposes to use this instrument for calibrating other current-measuring apparatus, for measuring electro-motive force (using it in connection with a resistance), and for determining the horizontal component of the earth's magnetism (employing it with a tangent galvanometer).

A LIGHT-WEIGHT PRIMARY BATTERY. — In France M. Renard has experimented for some time past on a navigable balloon. In order to obtain the power necessary to direct it, he has attempted to find an electric battery that is very light for its output, the question of economy not entering. None of the primary or secondary batteries in use would answer his purpose, and a new one had to be invented. After a number of experiments, he found that the best results were obtained by a cell in which the metals were zinc and platinized silver, while the liquid was a mixture of hydrochloric and chromic acids. The liquid is not very stable, but it can be kept for several days if it is not exposed to light. There is no local action in the cell if the chromic acid in the solution does not fall below one-seventieth of the equivalent for the hydrochloric acid present. The cells are made tube-shaped, the diameter being about one-tenth of the height. The potential is 1.2 volts; and from cells weighing thirty-three pounds, 200 to 250 watts per second have been taken for two hours and a half. For a storage-battery of the same weight, the energy could not be taken out at a rate of more than 75 or 100 watts, and this at a low efficiency.

MENTAL SCIENCE.

The Effect of Practice upon Reading.

INASMUCH as all education is in essence mind-building reduced to an art, the strictly psychological study of mental phenomena must in the end yield results of high practical import. It is this conviction that has brought the psychologist and the educator into such close sympathy, and has brought the latter to eagerly await the results of the former's somewhat specialized and technical studies. To no topic is this more applicable than to the study of the times taken up by various simple psychic processes, and of the causes influencing such times. We here touch upon the very powers that the teacher aims to develop, and, if we can acquire a method of testing these powers, we are sure to learn more of their real nature. A very promising contribution in this direction has been recently published by Dr. G. O. Berger (*Philosophische Studien*, v. 1), an account of which will probably be of interest to American students.

Dr. Berger measured the time needed by the boys of the different classes of a German Gymnasium to read a given Latin passage. It will be remembered that the Gymnasium consists of six classes, or, as the three highest classes are each divided into two, of nine classes; and that the study of Latin is begun upon entering the school, and is continued with great zeal throughout the nine-years' course. The five scholars with the highest and the five with the lowest standing were chosen from each class. The average ages of these groups of ten scholars from the nine classes were 10.7, 12.0, 12.9, 14.2, 15.2, 16.4, 18.0, 18.6, and 21.6 years. The class preparatory to the Gymnasium was also tested, the average age of the boys being nine years. These last boys had no Latin instruction. Each Gymnasium scholar read (1) the first hundred words from Tacitus' 'Agricola' (Chapter I.), as well as (2) the next five hundred words, as rapidly as possible, with some sacrifice of distinctness, and (3) he again read the first hundred words with normal rapidity. The average number of seconds necessary to read a hundred words by the three tests for the boys of each class is as follows: —

Class.	VII.	VI.	V.	IV.	III b.	III a.	II b.	II a.	I b.	I a.
(1)	262	135	100	84	79	57	54	49	48	43
(2)	–	145	104	93	83	59	58	53	53	45
(3)	–	134	95	84	79	61	56	57	53	52

We see at once that the higher the class, the less time does it take for the boys to read Latin, and that this shortening of the time is in conformity with the general law of practice, — at first rapid, and then slower and slower. We see, too, that the most decided difference is between the boys who have had no Latin instruction and those who have just been initiated into its mysteries. The numbers in the second line are larger than in the first, indicating the difficulty of retaining this speed for a longer time. The differences are less as the boys are older, showing that the older boys have greater facility at protracted rapid reading. A similar test with Goethe's 'Egmont' (v. 2) resulted as follows: —

Class.	VII.	VI.	V.	IV.	III b.	III a.	II b.	II a.	I b.	I a.
(1)	72	55	43	37	39	28	27	26	25	23
(2)	–	56	43	39	40	30	28	26	27	24
(3)	–	48	40	39	41	33	30	33	30	30

The comparison of this table with the foregoing shows (1) the great difference in time due to the familiarity and comprehension of the vernacular; (2) that the additional effort needed to read five hundred German words is less than in the case of Latin; (3) that the great difference between VI. and VII. disappears, because all the boys are acquainted with German; and (4) that the curve of practice is generically the same in the two cases. A point of great interest, applicable to both languages, is that the difference between (1) and (3) is greatest with the older boys: in other words, when these read normally, they read for the sense, and thus slowly, while the younger boys read more mechanically. The familiarity of the passage, due to its being read a second time, even makes (3) shorter than (1).

To obviate the objection that this shortening of the time is due to a general quickening of the intellectual activities, and not to a practice in Latin, Dr. Berger tested the boys by measuring the times necessary for them to name (1) any one of a group of five or (2) of ten colors, as the above table shows this exercise, in which they

Class.	VI.	V.	IV.	III b.	III a.	II b.	II a.	I b.	I a.
(1) 5 colors	83	66	79	66	63	56	63	63	54
(2) 10 colors..........	135	99	119	123	100	91	112	99	86

have had no special practice, while exhibiting differences due to age does not at all correspond with the former differences.

The interesting point is to determine the nature of the psychic process by which this quickening of the process is brought about. If we divide the time consumed in reading into (1) the time for the impression to reach the retina and the brain, (2) that for recognizing it and calling up the appropriate sound-image, and (3) that for setting the vocal apparatus in working order, we recognize in (2) the important psychic factor. Previous experiments as well as ordinary observation have shown that the unit in reading is not the letter, but the word (adults reading a word almost as fast as a letter); that, furthermore, all the three processes overlap in time, and that the eye goes ahead of the voice. If the words are in construction, we can take in more of them at a glance, and so read faster. In the following table the first line, taken from the table above, gives the time for reading a hundred German words forming sense; the second line, the time for reading a hundred words not rationally connected.

Class.	VI.	V.	IV.	III b.	III a.	II b.	II a.	I b.	I a.
100 words in construction..............	55	43	37	39	28	27	26	25	23
100 words not in construction..........	60	50	49	48	41	38	37	38	32

The nature of the errors in reading, likewise points to a difference in the number of words grasped at one time. The youngest boys of class VII. misread letters or syllables, such as *eitra* for *citra*. Class VI. were more apt to mistake one word for another, *æstas* for *ætas*. The older boys misread sentences, but not so as to interfere with the sense. The shortening would thus be due to reading more and more words as wholes, and not as combinations of syllables. This can be verified thus: taking the classes by groups of three, the average times needed to read a hundred words in construction is, from the last table, 45, 31.3, 24.6 seconds; for disconnected words, 53, 42.3, 35.6 seconds; and the ratios of these pairs of numbers are 1.18, 1.35, 1.45, an increasing series. This means that the older boys profit more by having the words in construction than the younger ones. The same can be observed in the difference between the rapid and the normal reading of Latin, as noted above. The effect would be more noticeable in the case of Latin, for here at first the words are almost all mere sound-signs without associations with one another.

Dr. Berger then concludes (1) that the effect of practice is greatest upon the central psychic portion of the reading process; and (2) that it acts by increasing the scope of the mind, enabling it to take in more complex impressions as units, and enlarging the number of, as well as the associative links between, the impressions.

THE EFFECT OF STIMULANTS UPON THE RE-ACTION TIME. — Dr. Dehio (*Neurologisches Centralblatt*, Feb. 15) injected a dose of coffee in the form of caffeine subcutaneously, and administered tea containing 1.5 per cent of theine, and with the subject under the influence of the drug measured his re-action time, and the times necessary for simple psychic processes. He found that the simple re-action time tended to become shorter in the drugged than in the normal condition; the time necessary to choose between several modes of re-action (choice-time) was not affected one way or the other; while the time needed to find an association for a word or similar process was shortened and the variations in the times reduced under the influence of coffee, and was at first shortened and then lengthened under tea. This double effect of shortening followed by lengthening is also shown under alcohol, but alcohol affects the choice-time, while tea does not. Again: in the apperceptive processes the shortened times under tea last for some time before the lengthening sets in, while the corresponding period is brief with alcohol. The general effect of alcohol is to excite, while tea induces fatigue.