THURSDAY, NOVEMBER 22, 1894.

PSYCHOLOGY OF MENTAL ARITHMETICIANS AND BLINDFOLD CHESS-PLAYERS.

Psychologie des Grands Calculateurs et Joueurs d'Échecs. Par Alfred Binet. (Paris: Hachette and Cie., 1894.)

WHOEVER may hereafter write about mental imagery will be imperfectly equipped for his task unless he has mastered the contents of this curious and instructive volume. It analyses the mental processes of two groups of remarkable men—those who possess extraordinary powers of mental arithmetic, and those who are capable of playing eight or more games of chess, blindfold and simultaneously. The idea of making the inquiry is due to the late Prof. Charcot; its prosecution has been conducted almost wholly by M. Binet, and principally at his laboratory in the Sorbonne. The prosecution of such an inquiry with the accuracy needed by modern psychology is exceedingly difficult, and it is also very difficult to express such results as may be obtained from it, in unambiguous language. The author has, however, succeeded in the latter as well as in the former, and he has framed many happy turns of expression which will contribute to the much desired evolution of psychological language.

The book begins by quoting the series of historical cases of mental arithmeticians, that was published by Scripture in 1881, in the *American Journal of Psychology*. They suffice for making useful generalisations, though few of the cases were tested with much precision. Then the original work commences. It refers to two remarkable calculators, who are now living, both of about the age of twenty-six, but whose mental processes entirely differ in their most obvious characteristics. The one is Inaudi, a Piedmontese, who performs his mental sums wholly, or almost wholly, by imagined sounds, *one*, *two*, *three*, &c.; the other is Diamandi, a Greek, who attains the same end almost wholly by imagined figures, as 1, 2, 3, &c. The careful testing of these two men, and the analyses and comparisons of the results, show the strange unlikeness of human minds in the above well-marked features, accompanied, it may be, with a nearer likeness in those deeper and more obscure qualities, which are exceedingly difficult to grasp. I, myself, had the pleasure of testing Inaudi at my own house, in company with a few scientific friends. Even the small number of experiments that there was then time to make, rendered it clear to my own mind that the conclusions which had been arrived at, after prolonged and careful experiments in France, were quite justified, namely, that he performs his long sums almost wholly by his auditive imagination, supplemented possibly by the motive, or gesture sense, but that the visual form of imagination was practically absent during the calculations. His case is an extremely rare one, and proportionately valuable for study. On the other hand, Diamandi is an excellent example of the common type of mental calculators, who work almost wholly by the visual imagination. A comparison between the achievements of Inaudi and Diamandi under similar tests, is the main feature of the first half of Binet's volume. He succeeds in distinctly negativing the assertion that the visual memory, even of a man who is so exceptionally gifted in that way as Diamandi, resembles actual vision either in its accuracy or in its completeness. Thus if a small square table of twenty-five figures, five figures in breadth and five in height, is shown to and learnt by Diamandi, he takes only nine seconds to repeat them in successive lines, but if he is asked to repeat them in the order of the columns, he is just four times as long in doing so, whether the columns are mentally read from their tops downwards, or from their bottoms upwards. He does not therefore read the figures as if they were written on a mental blackboard, which could be done as easily in any one direction as in any other, but he has, in some obscure way, to puzzle the figures out. When another table of twenty-five figures is taken, in which the figures are variously coloured, Diamandi's power of re-presenting colours being about as strong as that of re-presenting form, he has no difficulty in learning them, but he does it by two successive operations, first learning the figures and then the colours, and he is consequently twice as long over his task. This could hardly be the case if the visualised schedule had the completeness of an "after-image" or of a photographic plate.

A great difficulty in the way of testing the power of the memory of professional calculators is caused by their habit of accumulating large stores of mnemonic helps, which produce results that simulate those of a direct memory. It is indeed difficult for any one to free himself wholly from the use of such helps, which arise unbidden, more or less consciously, certain runs of figures, or accidents of position in the page, being more readily fixed in the memory than others. Binet's chapter on this subject is very instructive.

The most famous calculating boys had their calculating faculties developed very early in life. Many began to calculate of their own accord before they could read or write, and for the most part they were born in humble circumstances. It is found, so far as present information goes, that they did not inherit their gifts, except in a few cases, of which the Bidder family is a conspicuous instance. For my own part, I hesitate for awhile to accept the above negative result as a fact, and on the following grounds. Two mental peculiarities have to concur in the making of a calculating boy; the one is a special capacity for mental calculation, and the other is a passion to exercise it. Both of these peculiarities are rare, and they are not necessarily coordinated, therefore the chance of their concurrence in full force may be very small indeed. I have, however, reason to suppose that the capacity for mental calculation is more common than is usually believed, but that it does not commonly interest its possessor, and may even be unknown and consequently neglected by him. Trustworthy evidence for or against its hereditary transmission could hardly be obtained under these conditions. I may quote the case of a deceased lady of remarkable ability, which I indirectly verified to my own satisfaction at the time. She told me, and her husband confirms my recollection, that one night, while travelling to the south of France, she could not sleep, so she

amused herself, as is common on such occasions, with various idle trains of thought. Then it occurred to her to try mental sums, and finding, much to her surprise, that she had great facility in doing them, she became interested and exerted herself to the utmost. Before her train had reached Lyons, she had successfully multiplied one series of eleven figures into another series also of eleven figures. She subsequently trained herself to multiply fifteen figures into another fifteen. I am informed that her first attempt at the latter had one error, and, on being told that it was not correct, she went over it again mentally and gave the correct result. Another case comes to my memory. It appears that there was a craze for mental arithmetic in the period 1820–30, or thereabouts. My father was interested in the subject and made experiments on many friends and on all his servants, with the result, as I used to hear, that the best performer of all, and a really remarkable one, was a somewhat obtuse and uninteresting servant girl. She took no especial pleasure in calculation, and on that account would never have made a study of its processes by herself; nevertheless, she had the capacity for using them. An innate passion for arithmetic, such as all the great calculators possessed, is certainly uncommon. If only a moderate passion for it should exist, it is likely to become repressed by circumstances, because it is nearly useless to the possessor. It is difficult to imagine that anyone who was not fascinated by figures would devote the best part of his time and energy to them. Professional calculators are said to be usually (by no means always) narrow-minded, and to have their heads filled with mnemonic contrivances.

I may be permitted to allude to an inquiry analogous to that which has here been made into the visual and auditive imaginations, which I made on myself, on a small scale, in respect to the olfactile imagination. I tried to perform mental arithmetic, not by imaginary visual symbols, or by imaginary sounds, but by imaginary smells. As sums are set in the two former cases, either in really visible symbols or in really audible sounds, while the results are reached through imaginary ones, so in my experiment the sums were set in real odours, and were worked out through imaginary odours. I described the result briefly, not many months ago, in the *American Psychological Review*, and think the inquiry worth repetition, especially by experimenters who may possess the power of re-presenting odours to themselves more vividly than I have. It would enable them to perceive the processes gone through in mental arithmetic from a new point of view. My apparatus consisted of glass tubes, each drawn to a nozzle at one end like a short syringe. One end of a piece of india-rubber tube, six or eight inches long, was pushed tightly over the other end of the glass. A different odorous substance, camphor, carbolic acid, gasolin, &c., was inserted and packed lightly with cotton wool in the several tubes, whose ends were afterwards tied up. On grasping one of these tubes tightly, at the moment when its nozzle was brought to the nostril, a whiff of its peculiar odour was ejected and simultaneously sniffed up. This could be rapidly repeated three or four times without much diminution of the odour of the whiff. (An arrangement with valves would have much improved its action, by ensuring that no air should be ejected that had not passed through the scent.) I thus possessed a set of tubes that could be used *smellingly*, in the same way as the symbols 1, 2, 3, &c., are used visually, or the words *one*, *two*, *three*, &c., are used audibly. This is not the place to enter into further details. I only desire to emphasise one fact which the experiment taught me, namely, the existence of a large substratum of mental work that my power of introspection failed to penetrate. I progressed far enough to be able to add or subtract small sums, so that a 1 followed by a 2, both in smell language, associated themselves at once with the imaginary sniff of a 3, whenever I was engaged in addition, or with that of a 1 when I was engaged in subtraction. But the two associations of 3 and 1 never clashed; they were mutually exclusive. I could not ascertain through introspection what was the nature of the *attitude of mind* which determined whether the association was to be the one needed for addition or for subtraction, for division or for multiplication. Another point that strongly impressed me was the enormous amount of labour that must have been gone through by all of us in thoroughly learning the multiplication table. I made a very few similar experiments with the gustatile or taste-imagination, but they were troublesome, and I did not follow them up.

There is little room now left to speak of the latter half of Binet's volume, which refers to the great chess-players, who play eight or more games blindfold and simultaneously. The evidence is overwhelming that the faculty of visualising is not exercised by them in the same sharp and distinct way that it is commonly supposed to be They do *not* see the chessmen and the complete board all at once and with clear definition, but they commonly see all besides the portion they are considering, more or less vaguely, and they appreciate the positions of the men as hidden centres of forces. Two letters, which close the volume, by the distinguished chess-players Goetz and Tarrasch, seem to me models of exact introspection and of clear description. FRANCIS GALTON.

THE COLLECTED WORKS OF OLBERS.

Wilhelm Olbers, sein Leben und seine Werke. Im Auftrage der Nachkommen herausgegeben von Dr. C. Schilling. Erster Band, Gesammelte Werke. xix. + 707 pp. 8vo., with portrait. (Berlin, 1894.)

GERMANY has not produced as many amateur astronomers as England has, but among them the man whose complete writings have now been published occupies a most remarkable place. Olbers was an amateur, but his work was that of a professional astronomer. Though occupied all day in the extensive practice of a physician, he devoted his nights to searching for comets, making micrometric observations of these bodies, whether found by himself or others, with the annular micrometer, an instrument the immense value of which he was the first to perceive, and computing their orbits by the simple method devised by him, which he is said first to have applied practically while watching at the bedside of a patient. At the top of his house in the Sandstrasse in Bremen he had his exceedingly