THE TIME IT TAKES TO SEE AND NAME OBJECTS.

By James McKeen Cattell.

The relation of the sensation to the stimulus and the time taken up by mental processes are the two subjects in which the best results have been reached by experimental psychology. These results are important enough to prove those to be wrong who with Kant hold that psychology can never become an exact science. It would perhaps be convenient to call the work done by Weber, Fechner and their followers in determining the relation of the sensation to the stimulus Psychophysics, and to confine the term Psychometry to the work done by Wundt and others in measuring the rapidity of mental processes. Psychometry seems to be of as great psychological interest as Psychophysics, but it has not been nearly so fully and carefully worked over. This is partly due to the difficulties which lie in the way of determining the time taken up by mental processes. Such a time cannot be directly measured; the experimenter can only determine the period passing between an external event exciting mental processes and a motion made after the mental processes have been completed. It is difficult or impossible to analyse this period, to give the time required for the purely physiological operations, and to decide what mental processes have taken place, and how much time is to be allotted to each. Experimenters have also met with two other difficulties. The physical apparatus used seldom produces the stimulus in a satisfactory manner or measures the times with entire accuracy, and must be so delicate and complicated that it requires the greatest care to operate with it and keep it in order. The other difficulty lies in the fact that the times measured are artificial, not corresponding to the times taken up by mental processes in our ordinary life. The conditions of the experiments place the subject in an abnormal condition, especially as to fatigue, attention and practice, and the method has often been such that the times given are too short, because the entire mental process has not been measured, or too long, because some other factor has been included in the time recorded. Considering therefore the difficulty of analysing the period measured, the inaccuracies of the recording apparatus, and the artificial and often incorrect methods of making the experiments, we have reason to fear that the results obtained by the psychologist in his laboratory do not always give the time it takes a man to perceive, to will and to think. Wundt has done much toward obviating these difficulties, carefully analysing the various operations, and improving the apparatus and methods. It has seemed to me, however, worth the while to make a series of experiments altogether doing away with involved methods and complicated apparatus, and looking to

determine the time we usually require to see and name an object, such as a letter or a colour.

(1) I pasted letters on a revolving drum (a physiological kymograph) and determined at what rate they could be read aloud, as they passed by a slit in a screen. It was found that the time varied with the width of the slit. When the slit was 1 cm. wide (the letters being 1 cm. apart) one letter was always in view; as the first disappeared the second took its place, &c. In this case it took the nine persons experimented on (university teachers and students) from $\frac{1}{3}$ to $\frac{1}{2}$sec. to read each letter. This does not however give the entire time needed to see and name a single letter, for the subject was finding the name of the letter just gone by at the same time that he was seeing the letter then in view. As the slit in the screen is made smaller the processes of perceiving and choosing cannot so well take place simultaneously, and the times become longer; when the slit is 1mm. wide the time is $\frac{1}{4}$sec., which other experiments I have made prove to be about the time it takes to see and name a single letter. When the slit on the contrary is taken wider than 1 cm., and two or more letters are always in view, not only do the processes of seeing and naming overlap, but while the subject is seeing one letter, he begins to see the ones next following, and so can read them more quickly. Of the nine persons experimented on four could read the letters faster when five were in view at once, but were not helped by a sixth letter; three were not helped by a fifth and two not by a fourth letter. This shows that while one idea is in the centre, two, three or four additional ideas may be in the background of consciousness. The second letter in view shortens the time about $\frac{1}{10}$, the third $\frac{1}{50}$, the fourth $\frac{1}{100}$, the fifth $\frac{1}{200}$sec.

(2) I find it takes about twice as long to read (aloud, as fast as possible) words which have no connexion as words which make sentences, and letters which have no connexion as letters which make words. When the words make sentences and the letters words, not only do the processes of seeing and naming overlap, but by one mental effort the subject can recognise a whole group of words or letters, and by one will-act choose the motions to be made in naming them, so that the rate at which the words and letters are read is really only limited by the maximum rapidity at which the speech-organs can be moved. As the result of a large number of experiments the writer found that he had read words not making sentences at the rate of $\frac{1}{4}$sec., words making sentences (a passage from Swift) at the rate of $\frac{1}{8}$sec. per word. Letters not making words were read in $\frac{1}{10}$sec. less time than words not making sentences; capital and small letters were read at the same rate, small German letters slightly and capital German letters considerably more slowly than the Latin letters. The experiments were repeated on eleven other subjects, confirming these results; the time required to read each word when the

words did not make sentences varying between $\frac{1}{4}$ and $\frac{1}{2}$sec. When a passage is read aloud at a normal rate, about the same time is taken for each word as when words having no connexion are read as fast as possible. The rate at which a person reads a foreign language is proportional to his familiarity with the language. For example, when reading as fast as possible the writer's rate was, English 138, French 167, German 250, Italian 327, Latin 434 and Greek 484; the figures giving the thousandths of a second taken to read each word. Experiments made on others strikingly confirm these results. The subject does not know that he is reading the foreign language more slowly than his own; this explains why foreigners seem to talk so fast. This simple method of determining a person's familiarity with a language might be used in school-examinations.

(3) The time required to see and name colours and pictures of objects was determined in the same way. The time was found to be about the same (over $\frac{1}{2}$sec.) for colours as for pictures, and about twice as long as for words and letters. Other experiments I have made show that we can recognise a single colour or picture in a slightly shorter time than a word or letter, but take longer to name it. This is because in the case of words and letters the association between the idea and name has taken place so often that the process has become automatic, whereas in the case of colours and pictures we must by a voluntary effort choose the name. Such experiments would be useful in investigating aphasia.

A more detailed account of these experiments, and of the methods used, will be found in Wundt's *Philosophische Studien*, ii. 4.