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MENTAL SCIENCE.

The Time-Sense.

A GREAT deal of experiment and discussion has been expended upon the means by which we estimate time-intervals. Different observers have obtained quite opposite results, and the entire problem seems to become more complex as study is expended upon it. The usual form of experiment consists in reproducing various intervals, as produced by the beats of a metronome or otherwise, as accurately as possible under different conditions. The difference between the true interval and the average of the reproduced intervals is then calculated, and measures the constant error; while the average deviations of the several reproductions from their mean measures the variable error. The intervals thus tested were usually very brief ones, rarely being as long as a minute. On the other hand, we have an idea of time from the relative filling-out of the interval with mental experiences. A time during which much has happened seems long: one during which little has happened seems short. The latter may be regarded as a truly mental mode of estimating intervals; but it will be readily seen that it is only roughly approximate in character, and is not applicable to such small intervals as those usually experimented upon. What, then, is the means by which we gain our notions of the duration of these short artificial time lengths; such, for instance, as we employ in music and other rhythmical occupations? This is the problem that Dr. Münsterberg has recently studied in quite an original way.[1] His reflections upon the matter led him to the opinion that for these brief intervals we have no time-sense in the strict sense of the word, but that our estimates depend upon the feelings of tension, of arrest or delay, of ordinary physiological functions; and according as the end of the interval comes upon the rise or the fall of this tension-wave will a time-interval change its character. It is rather difficult to more accurately specify the subjective feelings which one experiences in waiting for intervals or in following them, but one factor most readily observed is the variation in breathing. We have all had some experience in the change of the breathing-rate under different emotions. Breathing, too, being one of the most constant bodily rhythms, it is not improbable that this affects our notions of time. To test this, Dr. Münsterberg arranged his apparatus in the usual way, first giving an interval varying from 6 to 60 seconds, and then having the subject mark off an interval equal to it: the average error in so doing was 10.7 per cent. He now had the experiments so arranged that the second sound, closing the original interval, came at the same respiratory phase as the first or opening sound of the interval: then the error was only 2.9 per cent. In this series the sound closing the original interval was at the same time the sound opening the reproduced interval. In a following series of experiments each interval had a separate opening and closing sound. When no attention was paid as to the concurrence in the respiratory phase of the opening and closing sounds, the error was 24.0 per cent, while when this was taken into account the error was only 5.3 per cent. In a third series the attention was purposely withdrawn from the respiratory and tension feelings, and the time judgments became utterly confused. While these experiments are too few to be taken as at all decisive, they certainly suggest a very interesting field of research, and, furthermore, open out some possibility of explaining the various results of different observers.

Visual Space Measurements.

The sense that above all others gives us our knowledge of extension in all the dimensions of space is the sense of vision; but, as we approach the problem more carefully, we see that there are several modes of perceiving sensations of length by the eyes. There is, first, the passive impression of a length upon the retina, which is analogous to the impression on the skin when an object, such as the edge of a ruler, is in contact with it. In both cases it is very essential to the notion of extension thus formed on what part of the skin or the retina the image is impressed. There are finely and coarsely sensitive portions of both skin and retina; and the general law is, that the same amount of objective stimulation will give a more extended sensory effect upon the more finely sensitive surface. The centre of the eye is by far the most sensitive portion, and hence we habitually turn the eyes so that the object to be seen falls upon it; and it is the space-sense of this portion of the eye that is usually tested. We have, again, the perception of space from the muscular effort needed to move the eyes so that the beginning and end of the length shall successively fall upon the fovea or central spot. In both these cases we must, to complete our estimate of length, take into account the distance of the object from the eyes; for size and distance are inversely dependent upon each other, and each becomes inferrible only when the other is known. Again, we have two eyes, which we ordinarily use together, but which we can use separately. The distances judged may be varied to an equal extent; they may be of any stated length within ordinary limits,—may be complete continuous lines, a series of points, or simple terminal points marking off a distance between them; they may be horizontally, vertically, or diagonally arranged; they may be symmetrically or asymmetrically situated with reference to the central axis of the eyes; and so on. It is evident, then, that we exercise our power of estimating distances by the eye in a large number of complex ways, and that to introduce system into the problem of how these estimates are made it is necessary to test the space-sense of the eye under different and definite conditions. This Dr. Münsterberg[1] has recently attempted by the following method. Two small squares of cardboard are seen on a green ground with a

[1] H. Münsterberg, Beiträge zur Experimentellen Psychologie, Heft 2.