GENERAL REVIEWS AND SUMMARIES

CUTANEOUS, KINAESTHETIC AND MISCELLANEOUS SENSES

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Cutaneous Sensation.—Practically all the literature of the past year on cutaneous sensation has had to do with the temperature sense. Perhaps the most significant article is that of Goldscheider (12). He has been led to a retrial of his results by the disagreement of other authors. Where he found 68 cold and 56 warm spots, Sommer found only 13 cold and 2 warm. Blix and Donaldson found thick spots so large that one of them would cover a number of Goldscheider's. von Frey maintained that warm spots were not sharply-defined points, but rather little fields in which sensitivity shades off at the edges. Goldscheider's retrials all support his earlier conclusions. The differing results of other investigators are due, he thinks, to the fact that they have not used fine enough stimuli, and have not, therefore, succeeded in stimulating single spots. Further, the warm and cold spots represent the only peripheral sense-organs for temperature stimulations. The interspaces are not sensitive to warm and cold. Wherever this seemed to be the case it was always found that certain single spots had been overlooked. In opposition to Head, who held that the phenomenon of adaptation is connected with the interspaces, Goldscheider maintains that it is everywhere connected with the spots. Finally, he has succeeded in arousing a paradoxical sensation of warmth by stimulating a warm spot with a moderately cold stimulus. He thinks that the failure of previous investigators to observe this phenomenon is due to the fact that they have used stimuli that were too cold, the cold acting as an inhibition on the warmth nerves.

Rubin (20) also notes paradoxical sensations of warmth. In general the results of the experiments reported in his article lend a support to the Weber theory of temperature sensation. This theory holds that sensations of warmth and cold are conditioned by a rise or fall in the temperature of the skin. By stimulating a small por-

tion of the skin with a carefully regulated stimulus, Rubin finds that a sensation of temperature results only as long as the temperature of the skin is changing. The Weber theory, however, meets its greatest difficulty in cases of long-continued cold or heat. The hand exposed to the freezing air feels cold for a very long period. According to the Weber theory the skin must be changing in temperature during all this time. To test this, Rubin had the subject bare his arm in a cold room. A thermometer, fastened to the skin gave a pretty good rough estimate of its changes in temperature. The experiment lasted from 40 to 60 minutes and the thermometer recorded a decrease during all this time. Moreover, the greater the drop in temperature during any period the more intense were the cold sensations experienced. Other sensations—those of dull pain and stiffness—were also experienced, and the author thinks that in ordinary observation these are not distinguished from cold.

The influence of different skin temperatures upon the pressure sense is investigated by Godefroy (11). His experiments take their departure from a statement made by von Frey to the effect that temperature had very little influence upon the threshold for pressure. The method followed was to keep the hand of the subject immersed in water of the desired temperature, and to determine the threshold for pressure of a certain spot at different temperatures. The spot to be investigated was previously marked, and the hand was held in such a way that the spot lay just beneath the surface of the water. The results show that temperature has no effect upon the sensitivity of the spot itself, but that it has an effect upon the sensitivity of the skin immediately surrounding it. Thus, if the stimulus is fine enough to affect the spot alone, there will be no change in the threshold with different temperatures; if, however, a coarser stimulus is used, it will cover more than the spot and the threshold will be affected. This result seems to reconcile von Frey's statement with the common observation that our hands are less sensitive to touch when they are cold than when they are warm.

Babák (2) contributes a comparative study. He found in earlier experiments that a decerebrated frog breathes with great regularity as long as it is undisturbed, but that any disturbing stimulus will effect a change in the rate of respiration. He now uses the changes in rate as an indication of the frog's sensitivity to warm and cold. As stimuli he used radiant heat and cold, a thermoesthesiometer being held 1 mm. from the frog's skin. The radiant form of stimulus was preferred because contact would give vitiating sensations of

pressure. Results showed that warm stimuli cause a marked increase in the rate of breathing. Cold, on the other hand, causes a decrease. For purposes of comparison special experiments were made with the same stimuli upon human subjects. The stimuli which had produced such marked changes in the frog's respiration were scarcely sensed by the human subjects. The author regards the "polarity" of his results—that warm and cold produce opposite effects upon the breathing reflex—as of great theoretical importance. He thinks it is evidence in favor of the theory that warm and cold processes are qualitatively different.

A very thorough study of cutaneous after-sensations has been made by Hayes (13). Eleven forms of stimulus were used, all of which produced very definite after-sensations in a large percentage of cases. A clear distinction between primary and secondary after-sensations is maintained throughout. A primary after-sensation is a sensation which persists after the stimulus has been removed, a secondary after-sensation is one which reappears after an interval during which there is no sensation. The secondary after-sensation does not occur as frequently as the primary, and when it does appear it is usually preceded by the latter. A secondary after-sensation sometimes differs in quality from that aroused by the original stimulus, but ordinarily it is the same. It is impossible to summarize the numerous particular results obtained, and they can be appreciated only by reference to the original article.

The results of Kiesow (14) have already been published in German, and were reviewed in the *BULLETIN* last year. Chinaglia (8), who was one of Kiesow's subjects, makes a preliminary report of an investigation growing out of Kiesow's. This was that flat, hollow objects, such as rings and triangles, when laid upon the skin were subjectively filled out so that they appeared continuous. Chinaglia finds that the phenomenon disappears when figures of greater size and weight are used. A pointed stimulus applied to the skin within the border of the figure will be localized somewhere outside it. If the skin is explored with a blunter stimulus this will be correctly localized. Another study along somewhat similar lines is made by Arps (1). He finds that when stimuli of some temporal duration are used, one sensation has an assimilative effect upon another. A normal stimulus of constant objective intensity seemed subjectively to vary in intensity with the varying comparative stimulus. No such effect could be found when stimuli of momentary duration were used.

Before closing the account of cutaneous sensation mention should

be made of the work of Kiesow and Ponzo (15), although it has to do more with reaction-time than with sensation. Ponzo (19) reports two new pieces of apparatus. One of these is an improved æsthesiometric compass, the other is his "dermocalimeter" which measures the direction as well as the amount of error in point-localization on the skin.

Kinæsthetic Sensation.—Three studies on the sensation of movement have appeared during the year. That of Erismann (10) undertakes a thorough investigation of the sources of error in experiments of this sort. It addresses itself further to the solution of two chief problems: (1) to investigate the difference-sensitivity for active and for passive movements and show their relation, and (2) to ascertain whether, in comparing two extents we depend essentially upon the times necessary to perform them. With regard to the first point he found that the difference-sensitivity for active and for passive movements is about the same. If anything, greater sensitivity is to be found in active movements. As for the second point, spatial estimates are influenced only slightly by temporal considerations, this influence being perhaps a little greater for passive than for active movements. In connection with the latter point, the work of Störing (21) is interesting. He found that the subjects fell into two classes. Those who depend in their estimation chiefly on visual imagery and the position of the hand were not influenced by the rate of speed at which the stroke was made. On the other hand, the subjects who made their estimation on the basis of the movement sensation itself were influenced in this way. Störing also makes a determination of the lowest threshold for movement. For this experiment he devised a very sensitive piece of apparatus which would measure movements of $1/600$ of a degree. Using this apparatus he found that horizontal movements of the elbow-joint could be sensed when their amplitude was no more than $1/200$ of a degree. Hitherto the smallest threshold has been that of Goldscheider, which was about $\frac{1}{2}$ of a degree. Störing thinks that his smaller result is due to the fact that in his experiments pressure sensations were not eliminated, and that these gave the subject his perception of movement.

Winter (23) is chiefly concerned with the question of whether the sensation of movement is derived from the muscles and tendons or from the joints. He determines the limen of movement at four different speeds and with the arm held so that the elbow-joint makes different angles. He also uses the electric current and ether for

anæsthetizing parts of the arm. Anæsthetization of the joint produces little if any effect upon the limen of movement. The angle at which the arm is bent in the experiment is found to have a great influence upon the limen. As this angle has a great effect upon the shape and position of the muscles and tendons, and very little effect upon the joint's action, it points toward the conclusion that the muscles and tendons are the seat of the sensation. This conclusion finds further support in the fact that anæsthetization of the muscles raises the limen more than anæsthetization of the joint. Allied to these investigations of the sensation of movement is the work of Ducceschi (9). He has discovered the little end-organs of Ruffini in the tongues of birds. His morphological conclusions do not concern us here, but his conclusion as to the function of these bodies is interesting. The first indication of this he found in the fact that the bodies are present in large numbers in the tongue of the parrot, but almost entirely lacking in the chicken's tongue. The parrot's tongue plays an important part in the process of eating and the chicken's a very minor one. The author is led to the belief that these bodies are the end-organs for the sense of movement. This view is further supported by other considerations, the most important one being that in the higher animals these bodies are present in greatest number in the connective tissues between the muscles, and in the periosteum.

Organic and other Sensations.—Cannon and Washburn (7) outline at length the two theories with regard to the sensation of hunger. One theory holds that it is a general sensation with a local reference, the other that it has a local peripheral source. Their own experiments support the latter view, showing as they do that the sensation of hunger is accompanied, or just preceded by a strong contraction of the stomach. These contractions were recorded directly on a smoked drum. Washburn, who acted as subject, accustomed himself to swallowing a rubber tube, to the end of which there was attached a small rubber balloon. He did this every day for several weeks, keeping the tube in about two or three hours each time. When he had grown quite accustomed to it the experiments were made. The balloon was inflated inside his stomach, and the end of the tube was connected with a water manometer provided with a float recording-device. Whenever the subject stated that he experienced the hunger sensation, powerful contractions of the stomach were invariably recorded. The contraction always coincided with the reported sensation, but came a little before it. This is taken as evidence that the contraction is the cause of the sensation. The intermittent char-

acter of the hunger sensation which psychologists have noted is explained by the periodicity of the contractions.

Neumann (18) recurs to the question of the sensibility of the inner organs in some experiments performed upon dogs. These form a continuation of his previous work with frogs. He succeeds in arousing pain reactions by pinching the intestine between the fingers and by stretching it. He also reaches further conclusions with regard to the distribution of nerves from the sympathetic system to the viscera.

Beck (5) reports a study of the static sense of deaf-mutes. In an investigation of thirty young deaf-mutes and an equal number of normal children he finds that the inferiority of the mutes shows itself only under artificially arranged conditions. As long as they have their eyes open they can balance as well as normal children. He had all the children perform various balancing feats blindfolded. It then appeared that the mutes were very much inferior to the normal children, and that the percentage of failures is great in proportion to the degree of deafness of the individuals. He also tested the mutes for their orientation in the water, and found that most of them were able to dive and swim perfectly well with their eyes blindfolded. Among those who did this successfully were some whose vestibular apparatus would not respond to the *Drehstuhl* experiment. These facts contradict the statement often met that deaf-mutes lose their orientation in the water.

Mann (16) describes the vestibular reactions that occur when a galvanic current is passed through the head from ear to ear. The functions usually attributed to the labyrinth are augmented on the cathode side and decreased on the anode side. One of these is bodily tonus. This does not manifest itself in a sinking or relaxation of one side of the body, but if two equal weights are held one in each hand, that in the hand on the anode side will appear heavier than the other, owing to the greater innervation necessitated by the decrease in tonus on that side.

Camis (6) shows that extirpation of the labyrinth on one side in rabbits, cats, and dogs, produces the same effect upon certain reflexes—pupillary, vaso-motor, etc.—as the severing of certain sympathetic nerves. Maxwell (17), experimenting with the horned toad on the turn-table, finds that its compensatory movements are not affected by a change in the distance of the animal from the center. With the same rate of rotation the compensatory movements are equal in extent whether the animal is 25 mm. or 300 mm. from the axis of

rotation. But if the animal is kept in the same place and the rate of rotation increased, the compensatory movements become greater. Thus, they are excited not by the centrifugal force, but by the angular velocity.

Two authors have attacked the question of sensations of tickle. Basler (3) finds the relation between the weight of a stimulus drawn across the skin and the intensity of the sensation of tickle aroused. There is a certain range of weight within which stimuli arouse maximum tickle sensations. If the stimulus is increased beyond, the sensations of tickle decrease, until finally only pressure sensations remain. His second article (4) is simply a continuation of the first, reporting experiments in which the method was applied to the sole of the foot. Basler is led to the conclusion that the end-organs for sensations of tickle are localized both in the skin and in the deep-lying structures. Thöle (22), producing anæsthesia of the cord by injection of stovain and cocain, finds that sensitivity to itch disappears just before sensitivity to pain, and regenerates just after pain. Tickle bears a similar relation to touch. He concludes from his observations that itch is due to a partial arousal of pain fibers. Tickle is related to touch in the same way.

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PSYCHOPHYSICAL MEASUREMENT METHODS

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The relation between the method of just perceptible differences and of constant stimuli is one of the most disputed problems of psychophysics. It has been shown that both methods give the same result, if the calculations are made on the same material, while the results differ if the material for the method of just perceptible differences is collected in the traditional way. The reason is that in these experiments the subject almost unavoidably obtains some information as to the objective relation of the stimuli, while all such information can be withheld in the method of constant stimuli. The attitude of the subject in the two methods is different and one must not expect that the results obtained under different conditions should be directly comparable. Fernberger (2) raised the question whether the experiments for the method of just perceptible differences could be performed in such a way as to prevent the subject from obtaining