and *d* ; but if the points touch *c* and *e* there will be a double sensa­tion, because the "circle” *d* intervenes. Again, in fig. 11, where the “ circles ” are much smaller and more numerous, the minimum distance at which two sensations are experienced is much less than in fig. 10, for this would happen when the compasses touch *a* and *d.* It will also be observed that the same distance *d e* in fig. 10 would give a single sensation, whilst it would give a double sensation in fig. 11. But *c e* in fig. 10 gives a double sensation, and yet the same distance would give a single sensation if the points of the com­passes touched adjoining “circles.” A “circle of sensibility,” however, cannot be regarded as an anatomical magnitude or “ cutaneous sensory unit,” or, in other words, the area of distribu­tion of a single nerve-fibre. The extent of any such hypothetical circle can be altered by practice and attention, and we may therefore assume that the circles overlap, and that even the same area of skin receives numerous nervefila­ments, and that consequent­ly, when a body is touched, it excites at once many fila­ments. This is illustrated by fig. 12.

It will be seen that each area receives a certain num­ber of nerve fibres and each nerve fibre supplies fibrils that cross the fibrils of ad­joining nerves. If the point of the compass touch at *a*, it will irritate all the fibres from 1 to 7, but these will not be excited with equal in­tensity ; the excitation will be at a maximum at 4, more feeble for 3 and 5, and still more feeble for 2 and 6; so that the intensity of the excitation may be represented by the curve above *a.* In this case the sensation will be that of one point, because all the fibrils have been excited. If the other point of the compass be placed at *b,* there will be an intermediary region not excited, and two points will be felt. Suppose now the second point of the com­passes is moved to c, all the fibrils between the two points *a* and *c* are excited, and there is likely a sensation of single contact; but the excitation of the fibrils 7 and 8 is very feeble, and it is possible, by attention and practice, to leave these out, and then there will be a sensation of two contacts (Beaunis). This mechanical theory has no anatomical basis, except it be the statement made by Krause that the distance of the two points of the compasses at which two points are felt includes in the mean 12 tactile corpuscles. Whilst atten­tion has been mainly directed to the skin as the locality where an anatomical explanation is to be sought for, it must not be forgotten that processes may be in operation in the nerve centres. It is well known that irradiation of nervous impulses occur in the nerve centres (see Physiology, vol. xix. p. 29), and it is not unlikely that, when a nervous impression reaches the brain from a particular area of skin, this may be diffused to neighbouring nerve-cells, exciting these, and that then the effect on these cells, in accordance with the law that sensations in nerve centres are referred to the origins in the periphery of the sensory nerve fibres reaching them, will be referred to adjoining areas of skin, or, in other words, to adjoining points in the tactile field.

Wundt has propounded a psycho-physiological theory that every part of the skin with tactile sensibility always conveys an impres­sion of the locality of the sensation. Each area of skin has a “local colour,” and this diminishes from area to area. The grada­tion is sudden where the sense of locality is acute and gradual where it is obtuse. “A circle of sensation is an area where the local colour changes so little that two separate impressions fuse into one ” (Landois). Practice enables one to notice the changes of local colour, and thus more and more accurately to discriminate points closer and closer together. This theory does not appear to explain anything; it simply restates the phenomena for which an explana­tion is desired.

Sensations of Temperature.—The skin is not merely the seat of tactile impressions, but also of impressions of temperature. This depends on thermic irritation of the terminal organs, as proved by the following experiment of E. H. Weber:—“If the elbow be dipped into a very cold fluid, the cold is only felt at the immersed part of the body (where the fibres terminate); pain, however, is felt in the terminal organs of the ulnar nerve, namely, in the finger points; this pain, at the same time, deadens the local sensation of cold.” If the sensation of cold were due to the irritation of a specific-nerve fibre, the sensation of cold would be referred to the tips of the fingers. When any part of the skin is above its normal mean temperature, warmth is felt ; in the opposite case, cold. The normal mean temperature of a given area varies according to the distribution of hot blood in it and to the activity of nutritive changes occurring in it. When the skin

is brought into contact with a good conductor of heat there is a sensation of cold. A sensation of heat is experienced when heat is carried to the skin in any way. The following are the chief facts that have been ascertained regarding the temperature sense. (1) E. H. Weber found that, with a skin temperature of from 15°∙5 C. to 35° C., the tips of the fingers can distinguish a difference of ∙25° C. to ∙2° C. Temperatures just below that of the blood (33° C.͟ 27° C.) are distinguished by the most sensitive parts, even to ∙05° C. (2) The thermal sense varies in different regions as follows :— tip of tongue, eyelids, cheeks, lips, neck, belly. The “perceptible minimum” was found to be, in degrees C. :—breast, ∙4°; back, ∙9°; back of hand, ∙3°; palm, ∙4°; arm, ∙2° ; back of foot, ∙4° ; thigh, ∙5°; leg, ∙6° to ∙2°; cheek, ∙4°; temple, ∙3°. (3) If two different

temperatures are applied side by side and simultaneously, the impressions often fuse, especially if the areas are close together. (4) Practice is said to improve the thermal sense. (5) Sensations of heat and cold may curiously alternate ; thus “ when the skin is dipped first into water at 10° C. we feel cold, and if it be then dipped into water at 16° C. we have at first a feeling of warmth, but soon again of cold ” (Landois). (6) The same temperature applied to a large area is not appreciated in the same way as when applied to a small one ; thus “ the whole hand when placed in water at 29° ∙5 C. feels warmer than when a finger is dipped into water at 32° C.

There is every reason to hold that there are different nerve fibres and different central organs for the tactile and thermal sensations, but nothing definite is known. The one sensation undoubtedly affects the other. Thus the minimum distance at which two com­pass points are felt is diminished when one point is warmer than the other. Again, a colder weight is felt as heavier, “ so that the apparent difference of pressure becomes greater when the heavier weight is at the same time colder, and less when the lighter weight is colder, and difference of pressure is felt with equal weights of unequal temperature” (E. H. Weber). Great sensibility to differ­ences of temperature is noticed after removal, alteration by vesi­cants, or destruction of the epidermis, and in the skin affection called herpes zoster. The same occurs in some cases of locomotor ataxy. Removal of the epidermis, as a rule, increases tactile sensibility and the sense of locality. Increased tactile sensibility is termed *hyperpselaphesia,* and is a rare phenomenon in nervous diseases. Paralysis of the tactile sense is called *hypopselaphiesia,* whilst its entire loss is *apselaphesia.* Brown-Séquard mentions a case in which contact of two points gave rise to a sense of a third point of contact. Certain conditions of the nerve centres affect the senses both of touch and temperature. Under the influence of morphia the person may feel abnormally enlarged or diminished in size. As a rule the senses are affected simultaneously, but cases occur where one may be affected more than the other. Herzen states that “limbs which are sleeping” feel heat and not cold (Landois).

Pain.—In addition to sensations of touch and of temperature referred to the skin, there is still a third kind of sensation unlike either, namely, pain. This sensation cannot be supposed to be excited by irritations of the end-organs of touch, or of specific thermal end-organs (if there be such), but rather to irritation of ordinary sensory nerves, and there is every reason to believe that painful impressions make their way to the brain along spinal tracks in the spinal cord. If we consider our mental condition as regards sensation at any moment, we notice numerous sensations more or less definite, not referred directly to the surface, nor to external objects, such as a feeling of general comfort, free or im­peded breathing, hunger, thirst, malaise, horror, fatigue, and pain. These are all caused by the irritation of ordinary sensory nerves in different localities, and if the irritation of such nerves, by chemical, thermal, mechanical, or nutritional stimuli, passes beyond a certain maximum point of intensity the result is pain. Irritation of a nerve, in accordance with the law of “ peripheral reference of sensation,” will cause pain. Sometimes the irritation applied to the trunk of a sensory nerve may be so intense as to destroy its normal function, and loss of sensation or anaesthesia results. If then the stimulus be increased further, pain is excited which is referred to the end of the nerve, with the result of producing what has been called *anæsthesia dolorosa.* Pains frequently cannot be distinctly located, probably owing to the fact of irradiation in the nerve centres and subsequent reference to areas of the body which are not really the seat of irritations. The intensity of pain depends on the degree of excitability of the sensory nerves, whilst its mas­siveness depends on the number of nerve fibres affected. The quality of the pain is probably produced by the kind of irritation of the nerve, as affected by the structure of the part and the greater or less continuance of severe pressure. Thus there are piercing, cutting, boring, burning, throbbing, pressing, gnawing, dull, and acute varieties of pain. Sometimes the excitability of the cutaneous nerves is so great that a breath of air or a delicate touch may give rise to suffering. This *hyperalgia* is found in inflammatory affections of the skin. In *neuralgia* the pain is characterized by its character of shooting along the course of the nerve and by