Seidel, by the Guyon School in Paris (Lannois, 1885; Arthaud, 1885).

The first change in the skin is the appearance of gray hair. The subcutaneous tissue atrophies, producing wrinkles, and the atrophy extends to the cutis. These changes are accompanied by atheromatous arteries and varicose veins.

Even the apparently stable skeleton suffers extensive alterations in old age. There is in general a tendency toward calcification of the cartilages and ankylosis of the joints and sutures, while the spaces within the bones become enlarged and the compact bone becomes more spongy. But arthritis deformans does not belong in the category of senile alterations, as it appears commonly at an earlier period.

Accompanying these changes, there is more or less atrophy of the muscles, sometimes with fatty infiltration. In the central nervous system there is some loss of weight and volume, often with local areas of degeneration; while the meninges become thickened and adherent. The brain is one of the organs in which the connection between the senile changes and an atheromatous condition of the vessels is most evident.

With the changes in the brain substance there appears a decline of its functions. The reflexes become slower and less intense. The organs of special sense become impaired, and there is a decadence of the intellectual and moral attributes.

Recently Mühlmann (1901) has described a deposition of fatty pigmented granules in nerve cells. This begins in the third or fourth year of life, the granules being at first scattered and later collected in a definite place in the cell. With age the number of cells showing this phenomenon gradually increases, and the amount of the inert, pigmented, fatty material becomes larger in each cell until in old age there is but little protoplasm left, for the cells do not increase in size. Mühlmann regards this as a normal process of senile degeneration, finally ending in death.

There are three principal theories as to the biological significance of senility: (1) Senility is the result of the inherent properties of protoplasm; (2) it is not due to the inherent properties of protoplasm, but has been acquired as a normal process by the multicellular animals and plants for the good of the species; (3) it is a pathological condition resulting from the imperfect adaptation of the organism to its surroundings.

Maupas in France and Minot in this country are among the chief advocates of the first theory. They imagine the organism to receive a store of vital energy at the time of fertilization, and this energy is supposed to be dissipated gradually until, if no accident occurs, the organism dies of old age. As evidence Minot cites the results of his investigations on the growth of guinea-pigs, in which it was shown that the rate of growth diminishes from the time of birth. (See *Growth.*) But it would seem that the facts could be accounted for equally well by the familiar physiological principle that with growth the surface for the absorption of food increases in proportion to the square of the stature, while the tissues to be fed increase as the cube. Thus, other things being equal, the larger the organism the slower would be the rate of growth.

The second theory is Weismann's. According to his view, the protozoa never die of old age. But the higher organisms have been endowed with senility and natural death through natural selection, those species which are composed of the greatest proportion of young uninjured individuals being the best fitted to survive the struggle for existence with other species. This involves the idea that senility is a normal condition like growth or hunger, which is denied by the advocates of the third theory.

Metchnikov (1899) has appeared recently among the latter with a remarkable hypothesis of phagocytosis as a cause of senile degeneration. He calls attention to the fact that the loss of the power of cell multiplication is not universal in old age, as one would expect it to be on the theory of senility being a normal process. On the contrary, the connective-tissue elements show a remarkable capacity for growth. He supposes a struggle for existence to be going on continually in the body, in which the megaphagocytes are on one side and all the remaining cells on the other side. These megaphagocytes attempt to attack and devour everything they touch, whether living or dead. Healthy living cells can resist them, but when a cell is weakened by any cause, for example, bacterial poison, the phagocytes are successful, and, after destroying the weakened cells, they take their place and change into connective-tissue corpuscles. Unfortunately for this hypothesis, however, there is very little observational evidence to support it.

On the other hand, there is abundant evidence of the close relation between senility and a diseased condition of the walls of the blood-vessels, and Thoma's main thesis that this condition arises primarily as an adaptive modification to meet unfavorable conditions of life harmonizes well with the facts. The pathologists are agreed that with the beginning of arteriosclerosis a vicious circle is soon established, resulting in the progressive increase of the various troubles associated with that disease. If this group of pathological conditions does not form the sole feature of senility, it certainly forms the most conspicuous one. And in the absence of any knowledge of the unknown conditions, if there be any, we should expect, on the theory of chances, that these unknown conditions would be of the same general character as the known conditions. Spencer has defined life as "the continuous adjustment of internal relations to external relations," and we may define senility as the progressive result of imperfect adjustment of internal relations to external relations.

Robert Payne Bigelow.

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SENNA, U. S. P., B. P. (*Folia Sennæ*, P. G.).—The dried leaflets of *Cassia acutifolia* Delile (*Alexandria Senna*), or of *Cassia angustifolia* Vahl (*India Senna*); fam. *Leguminosæ*.

In the United States, German, and French pharmacopœias, the general title covers both the principal varieties; in the British, the Alexandrian (*Senna Alexandrina*) and Tinnivelly (*Senna Indica*) sennas are distinguished by name; they are always entirely distinct in the market.

1. *C. acutifolia* Delile is a small shrub about a meter (a yard) high. Its pod is broad, flat, coriaceous, slightly curved, rounded, and oblique at the ends, containing about half a dozen seeds. This species has a wide and unknown range in Central Africa, is abundant in Nubia, Kordofan, Sennaar, etc., and is said to be found in Timbuctoo. The leaflets are gathered twice a year by native tribes and carried to Alexandria, where they are very carefully freed from sticks, stems, stones, and other impurities, and the broken and defective leaves separated, the different portions of leaf, even to the siftings, being marketed separately.

2. *C. angustifolia* Vahl. is also a small shrub, a good deal like the preceding, but it has larger flowers and larger, more numerously paired leaflets. Its pod is narrower and straighter than that of *C. acutifolia*, and contains about eight seeds. It is a native of Arabia, and in the wild state supplies an inferior, carelessly collected variety of senna (Arabian). It is also said to be found

in Somaliland. This is the species cultivated in the south of India (where it is not indigenous) as the source of Tinnivelly senna. The leaves, under cultivation, are increased in size and improved in quality.

Although the Alexandrian variety brings a higher price and is generally held in higher esteem, there seem no good grounds for the idea that it is essentially different in its action from the other.

DESCRIPTION.—*Alexandria senna* consists of leaflets with extremely short, stout petioles, about 2.5 cm. (1 in.) long and 1 cm. (⅜ in.) broad, inequilaterally lanceolate or lance-ovate, acutely cuspidate, entire, subcoriaceous, brittle, pale-green or slightly yellowish- or grayish-green, sparsely and obscurely hairy, more so underneath, the hairs appressed; odor peculiar, tea-like; taste mucilaginous, tea-like, bitterish.

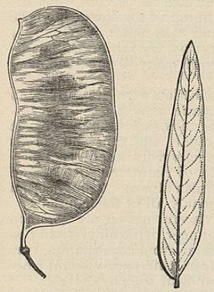

FIG. 4185.—Leaf and Pod of Cassia Angustifolia; about natural size. The leaf is Tinnivelly senna. (Baillon.)

It is frequently contaminated with the one-nerved, thick, wrinkled, glaucous, equilateral Argel leaves.

India senna leaves average nearly twice as long, though but little broader, are more abruptly pointed, usually more yellowish, and the hairiness is even more obscure.

CONSTITUENTS.—As to its active constituents, senna is closely related to rhubarb, cascara sagrada, and some other laxative and cathartic drugs. Like them, its active principles appear to be the anthraquinones emodin, isoemodin, and chrysophanic acid, all of which have been considered elsewhere, with which exist rhamnetin, a large amount of gum, a little tannin, and ordinary leaf constituents. Cathartic acid, formerly regarded as the active constituent, is apparently a mixed body, and fairly represents the properties of the drug. However, the administration of anything else than the entire drug, or a preparation of it, appears inadvisable.

ACTION AND USE.—This is one of the most satisfactory and generally useful of simple cathartics, usually emptying the bowels thoroughly in ten or twelve hours, with but little depression or other untoward effects, excepting a variable amount of griping; it acts principally upon the small intestine, and the amount of effect produced can generally be pretty accurately regulated, by the dose, from the mildest laxative to a brisk cathartic. It is in universal domestic use, and is the foundation of numerous proprietary laxatives. By combination with salines its activity is considerably augmented; in small doses it does not readily lose its efficiency. It appears to be partially excreted in the milk, when taken by nursing women.

ADMINISTRATION.—A few senna leaves chewed every day are a favorite habitual laxative with many people, who find them to act efficiently, without griping and without producing after-sluggishness of the bowels. One or two dozen leaves usually display some effect. In large doses (6 or 8 gm. [ʒ iss.] or more), as required for thorough action, it is apt to produce colic, unless modified by aromatics or salines. A strong alcoholic extract is inert; a watery extract, made from the residue after exhausting by alcohol, is active and much pleasanter than one made without this previous treatment. Infusion with hot water extracts the active principles and makes a good form for administration, but prolonged boiling destroys it, as do also mineral acids and alkalies. Bitters are said to increase its action.

The official preparations are numerous and good. The Fluid Extract (*Extractum Sennæ Fluidum*, U. S. P.), made with weak alcohol, represents the leaves weight for weight. It is not often given alone, but is eligible for mixture with other medicines. The Compound Infusion, Black Draught (*Infusum Sennæ Compositum*, U. S. P.), consists of: Senna, 6 gm.; manna, 12 gm.; sulphate of magnesium, 12 gm.; fennel, bruised, 2 gm.; boiling water, 800 c.c.

Pour the boiling water upon the senna and fennel, macerate until cold, strain with expression, dissolve in the Epsom salt and manna, again strain, and add enough cold water to make the infusion measure 1,000 c.c. The syrup has a strength of twenty-five per cent. of senna, and contains a little oil of coriander to flavor. The confection contains ten per cent. each of senna and tamarind, sixteen per cent. of cassia fistula, seven per cent. of prune, twelve per cent. of fig, and a little oil of coriander to flavor. It is a blackish extract-like mass of a sweetish taste, and is an appropriate remedy for chronic constipation, being especially useful for children, who take it readily. The compound syrup of sarsaparilla contains 1.5 per cent. of the fluid extract of senna. The compound liquorice powder has already been considered under *Liquorice*.

ALLIED PRODUCTS.—The leaves of a number of other species of the section of *Cassia* to which the official species belong, possess similar properties, though much weaker, and have been at one time or another proposed as substitutes, especially those of *C. obovata* Collad., widely diffused through the tropics of both hemispheres. No others, however, appear in commerce at the present day.

Henry H. Rusby.

SENSATION, DISORDERS OF.—The scope of the present article is the discussion in brief of those abnormalities of sense perception not described under separate headings. General sensibility is the name given to the power of perception possessed by the various body tissues other than those of special sense. It is not, however, homogeneous in kind nor equal in degree, but varies in acuteness, in localizing power, and in other ways. Sensitiveness of the skin and mucous membranes is divided into that to tactile, that to painful, and that to temperature impressions. Muscular sense is an indefinite feeling, by which the weight and size of objects are appreciated or approximated; it is probably composite, the feeling of tension in the muscles being supplemented by tactile impressions from the skin and other tissues. Visceral sensibility has a varying but comparatively slight localizing value. Its appeal is largely to the subconscious psychic stratum; when visceral sensations rise to the level of consciousness, they may consist of visceral pain, local or referred, or be felt as hunger, thirst, fright, nervousness, psychic pain, anger, and so forth. These feelings are more or less indefinite, often not referred to an organ or part of the body, although at times they may be somewhat localized,—as, for instance, hunger and depression as epigastric sensations, thirst as dryness in the mouth and throat.

The general sense of well-being on which happiness depends is a form of general sensation known to us mainly by its occasional loss, or rather by a feeling of definite depression, not usually localized, though sometimes felt as a cardiac or epigastric sinking or feeling of heaviness. An allied and in some ways opposite state is nervousness, a much abused term, but one of sufficient importance to deserve careful definition and description.

General sensibility, then, is a function of widely different tissues, much varied in kind, definiteness, and degree. The impact on consciousness due to sensory stimuli may give rise to intellectual or to emotional processes, the first being concepts relating to location, form, size, weight; the latter consisting of either pleasurable or painful feelings.

Disturbances of sensation are classed as anæsthesia,—that is, diminution or loss of sensitiveness, which has been described elsewhere in these volumes; hyperæsthesia,—that is, increased sensitiveness; paræsthesia,—that is, perverted sensitiveness; the different varieties of the latter are usually spoken of as paræsthesiæ. Variations in

sensitiveness are spoken of as hyperæsthesia or as paræsthesia only when they reach a marked degree and are the result of distinct morbid processes. Normal people vary widely in the acuteness of their perceptive power, both to tactile and to painful impressions; different parts of the body vary widely in sensitiveness, and acuteness of sensibility varies much in any given individual at different times of the day and even more with changing vascularity and varying degrees of heat and cold. Sensation present in consciousness varies almost directly in amount with expectant attention. Even the strongest stimuli may be disregarded and pass unnoticed under excitement or hypnotism.

Although sensation in its restricted sense is a mental impression received from a part of the bodily organism by way of the afferent nerves, and is thus necessarily conscious, the disorders resulting from sensation in the broad sense cannot be so limited. Sensibility is not originally conscious; the earliest and lowest sensory elements subserve the purposes of reflex action; they are evolved from cells capable of motion and possessed of digestive power, and develop their more acute sensory functions gradually. On about the same level are the sensory elements in vaso-motor action. Both these activities are carried on as well without the aid of consciousness, in fact often better, and they are not initiated either volitionally or consciously. Automatic action, as a higher and later manifestation of nerve force than either of the above, is nearer to consciousness. While some automatic acts, especially in the lower animals, are organic and inborn, many of them in man originate in conscious volitional acts and are the result of education.

In order to appreciate the importance of reflex and vaso-motor disturbances from derangement of the sensory mechanism, it is necessary to consider in brief the distribution of the sensory elements in the body. Sensory filaments of some kind are distributed to almost every organ and almost every tissue. Nerve filaments conveying impressions of pain are most abundant and active in the skin and the mucous membranes near the surface. The mucous membranes of the rectum, the tonsils, the stomach, and the intestines may be cut without causing much discomfort to the patient. The same is true of the muscular tissue and the brain. The arteries, on the other hand, are quite sensitive; the peritoneum and other serous surfaces, especially when inflamed, are exquisitely tender.

Tactile sensibility is also much more acute and finely differentiated in the skin and superficial mucous membranes. Touching and wounding the internal organs, the stomach, the bladder, and so on, give only a general idea of the seat of injury. Irritants at the neck of the bladder and in the rectum give the same feelings; pains are not distinguished as between the stomach and pancreas, the liver and gall-bladder, often not even between the appendix and the right kidney. The obvious reason for this fact is to be found in the rarity of opportunities for observing and learning to distinguish between pains in these different organs. How much might be learned if such opportunity existed we do not know. The frequency of referred feelings from visceral irritation, as compared with the rare occurrence of the same phenomena from the skin, points to the low tactile value of visceral sense impressions. Such impressions may be referred from one part of the abdomen to the other, from the teeth to the scalp, and even from the intestinal organs to remote regions of the skin. These referred pains will be described more fully later.

The main use of the sensory elements in the deeper structures is in the determining and controlling of vaso-motor and glandular action and the activity of the unstriped muscles; in other words, in carrying on the vegetative functions of the organism. These may be carried on very well without being brought to consciousness, and often when diseased they may be better performed if removed from consciousness. For instance, the reflex and automatic activity of the bladder is unimpaired in many cases of transverse and other spinal-cord lesions, cerebral control alone being lost. The peptic glands probably act largely though not entirely on direct stimulation, but the peristaltic movements of the stomach and automatic control of the pylorus require the intervention of the sensory apparatus, normally apart from consciousness.

The digestive and other visceral functions result in another set of changes which impinge on consciousness only incidentally, but are carried on by the intervention of the sensory system; vaso-motor changes occur in the viscera themselves, and circulatory disturbances often follow in distant organs. It is necessary only to mention as examples the flushing of the face that accompanies the same change in the mucous lining of the stomach on the ingestion of food, the profound vaso-motor changes that often occur at the menstrual period, the faintness amounting to collapse that occurs with many severe abdominal diseases.

In addition to, often in connection with, its activity in reflex, vaso-motor, and automatic acts, the sensory system contributes two elements to consciousness—the one emotional, the other intellectual; the skin and serous membranes furnish almost exclusively intellectual percepts and the single emotion of pain; the viscera and deep mucous membranes furnish almost no intellectual percepts, some pain, and probably all of the emotions.

The emotional results of visceral action are common and familiar. Anger from hunger, irritability from distention of the bladder, depression from constipation, nervousness and motor unrest from thirst are visceral reactions scarcely beyond the bounds of the physiologic.

The emotions are, normally, visceral reactions to psychic stimuli. The psychologic side of the subject has been carefully worked out by William James in his "Psychology." His theory is, in brief, that the psychic cause sets up a physical change in the viscera, and the sensations from these in turn, perceived by the brain, constitute the emotions. For instance, a financial loss or death of a friend causes a change in the heart and vascular system, the stomach, and other viscera. The feeble heart action, loss of appetite, and sense of unrest in the epigastrium are the direct results, not of an emotion following the bad news, but of the news itself. The emotion is the perception of the changed visceral action, and without this the loss would be perceived intellectually but not emotionally. The jaundice of anger, the excitement and accelerated heart action of joy, and the nausea of disgust are similarly explained as the direct result of psychic stimuli, and the emotions are the perception of the altered visceral conditions.

That the physical reaction follows directly on the psychic stimulus is often observed. A man who had never heard a rattlesnake, when walking on the prairie quite quietly, suddenly bounded out of the path, and only a moment after was aware of the rattling noise. In this case the reflex jump and accelerated heart action could have been dependent on no conscious emotion. Similarly men who have run away from battle assert that their legs carry them away before they realize what they are doing. The faster they run the more frightened they become. The contrary attitude of calmness is well known to restore confidence.

James says that when a boy he examined curiously a bucketful of blood at a butchering. He had never heard of fainting at the sight of blood, had no fear or other emotion, and was much surprised when he found himself growing dizzy and fell to the ground. The sight of blood on the next occasion might cause nausea and repugnance from the renewing of the previous experience in memory.

This brief statement of what may be called the visceral theory of the emotions must suffice. To be convincing it should be read *in extenso*. It is necessary to an understanding of the part played in the human economy by the sensory apparatus of both the viscera and the skin.

Increased sensitiveness to stimuli, called hyperæsthesia, is common and is even more important than anæsthesia as an indication of disease. Hyperæsthesia which consists of a heightened power to distinguish variations in temperature or other qualities of objects is rare. Such increase of capability may be regarded as supernormal.

It occurs in some sensitive and gifted individuals, but is usually not the result of disease. On the other hand, a painful reaction to what should be normally felt as touch, pressure, heat, or cold is common as either deep or superficial tenderness. It is one of the most important signs of disease, local or central.

It is important to distinguish between deep and superficial tenderness, as that to deep pressure usually indicates local disease, while tenderness to a light touch with a blunt object like a pinhead, or to pinching up the skin, usually if not invariably in the absence of a superficial and obvious lesion, is tenderness referred from a diseased viscus.

The headache due to brain tumor when associated with scalp soreness, elicited by gently pulling the hair or touching the scalp, is sometimes on the side opposite to the lesion; it has no localizing value, but indicates increased intracranial pressure.

Headaches from visceral disease have been confused with attacks of megrim. The tenderness of megrim, associated with scotomata, hemiopia, and fortification lines,* and sometimes with aphasia, is always to deep pressure. Visceral headaches are not associated with these symptoms; tenderness in them is superficial and confined to areas which depend on the viscera involved and on the tender areas set up by the same disease in other parts of the body.

The headache of hypermetropia comes on at the time of awaking in the morning; it is due to strain from overaction of the ciliary muscle, and is a true visceral pain. It is associated with a superficial area of tenderness over and just above the eyes. The same area, the midorbital, may, however, be tender as the result of disease of the nasal mucous membrane, the stomach, the heart, or the apices of the lungs. Other eye diseases cause pain and tenderness of other regions; glaucoma sets up pain in the temple, which is associated with nausea and vomiting, as are temporal pains from other causes; temporal headache is often associated with gastralgia, and may be due to gastric or thoracic lesions or disease of the bicuspid teeth.

Iritis causes tenderness in the fronto-temporal and maxillary areas. Liver disease causes vertical headache, and ovarian lesions are associated with pain and tenderness in the occipital region, often together with pain over the lower dorsal region of the spine.

The skin of the neck, trunk, and limbs may show hyperæsthetic patches from visceral disease, and there may or may not be with them like patches over the scalp, with headache. They are readily distinguished from the deep tenderness found in affections of the serous membranes, which is always local; for instance, the tenderness due to rheumatic inflammation of the joints, to peritonitis, to meningitis, is found on pressure over the affected structures; the pain of lumbago is similarly elicited; appendicitis sets up local tenderness as well as referred pains in the left side of the abdomen and left lumbar region. Disease of the uterus causes pain referred to the lower part of the back but does not cause headache. Ovarian and rectal diseases may cause pain down the thighs and in the feet, as well as hyperæsthetic areas over the body and head.

The hyperæsthesia of the trunk sometimes seen in tabes dorsalis has the characteristics of the referred variety of pain. The patient, over a greater or less and sometimes a varying area of skin, cannot bear the weight of clothing or the slightest rubbing with a towel. This symptom may persist for years. The lightning pains in the legs are associated with a like soreness, which is, however, much shorter-lived than the trunk anæsthesia, but which corresponds closely in its main features with the headaches referred from disease of the brain, the teeth, and other viscera.

* Gowers (p. 840, second edition) says: "When a luminous spot is the first change and this expands, it may become dim in the centre. Very commonly the outer edge assumes a zigzag shape with prominent and re-entrant angles, like the ground plan of a fortification, and hence called 'fortification spectrum.'" Mills also uses the expression "fortification lines."

The mode of production of referred pains is not known. To suppose them signals from the viscus and apprehended by the receiving stations in the brain as coming from the skin leaves out of account the tenderness, a local phenomenon, as are herpes and sympathetic inflammation. The setting up of such tender spots must be conceived of as a phenomenon analogous to the jaundice, indigestion, suppressed menstrual flow, and local flushings and pallors consequent on psychic shocks and associated with strong emotion. Whatever the explanation, they are important from the therapeutic as well as the diagnostic point of view. The frequency with which so-called osteopathic practitioners find tender spots in the back, and the fact that their removal by treatment usually gives the patient relief in spite of the persistence of organic visceral lesions make the treatment of tender spots, either local or referred, a matter worthy of attention.

The distinguishing marks of local and of referred pains and hyperæsthesia have been given above. A third variety of tenderness is important, viz., that due to inflammation of nerve trunks; such inflammation causes pain along the course of the nerve, with tenderness to deep pressure. This tenderness is due to involvement of the *nervi nervorum* in the nerve sheaths. When the skin supplied by the affected nerve is tender, it is so because the inflammation extends to and involves the terminal filaments and end bulbs. Thus both varieties of tenderness are local, not referred. The pain, however, caused by pressure on sensory nerve fibres anywhere in their course is referred to their terminations in the skin.

Paræsthesiæ are of two kinds: perverted spontaneous feelings other than pain, and perverted transmissions of stimuli to the sensory centres. Of the first of these, itching, ticklings, prickling and burning feelings, numbness, formication, and feelings of heat and cold are common. They may be due to disease in the peripheral nerves, in the cord, in the receiving centres in the brain, or they may be psychic. Of these, the immediate cause will usually be found in the periphery, and any other theory should be accepted with caution and only after careful exclusion of possible change in the nerve endings or small blood-vessels. Vaso-motor changes are prolific sources of paræsthesiæ of various kinds, and are a common accompaniment of central disease. Again, the scleroses, cerebral and spinal, are accompanied not only by vaso-motor and trophic changes, but also by lesions in the peripheral nerve tissues, so that in a large proportion of cases paræsthesiæ occurring in the course of central disease are found due to accompanying peripheral change.

Most of the paræsthesiæ will be found described among the vaso-motor, trophic, and cutaneous disorders. A curious form is the so-called allochiria, or reference of a stimulus to a corresponding spot of skin on the other side of the body. This symptom has been found in some cases of brain tumor, in sclerotic cord lesions, and in hysteria.

Muscular sensibility is the power of feeling in relation with muscular acts. It enables one to appreciate the strength of action of the muscles, the position of the limbs, the extent of objects, and, in the case of the eye muscles, it helps to maintain the equilibrium of the body, and gives information in regard to the size and distance of objects.

Muscular sense is not limited to sensitiveness possessed by the muscles. That the amount of force sent along the motor nerves is directly appreciated or estimated by the sending apparatus is probable, but hardly susceptible of proof. The amount of common sensibility possessed by the muscles themselves is much less than that of the ligaments, tendons, and connective tissues. The impressions conveyed to the brain are the sum of all the sensations set up by strain and pressure in all of these tissues, as well as in the skin, and even in the blood-vessels, their rich sensory nerve supply being affected by pressure of the surrounding parts and the amount of contained blood varied by pressure and change of position.

When an act or series of acts is once carried out as the result of a stimulus, it follows that stimulus the next time with greater ease. Such an impression stored up is