

Phenomena of life maintained and controlled by two antagonistic principles of innervation. Anatomy of the iris reviewed; value of the irian variations in diagnosis. Diphtheria. Poisoning treated on physiological principles.

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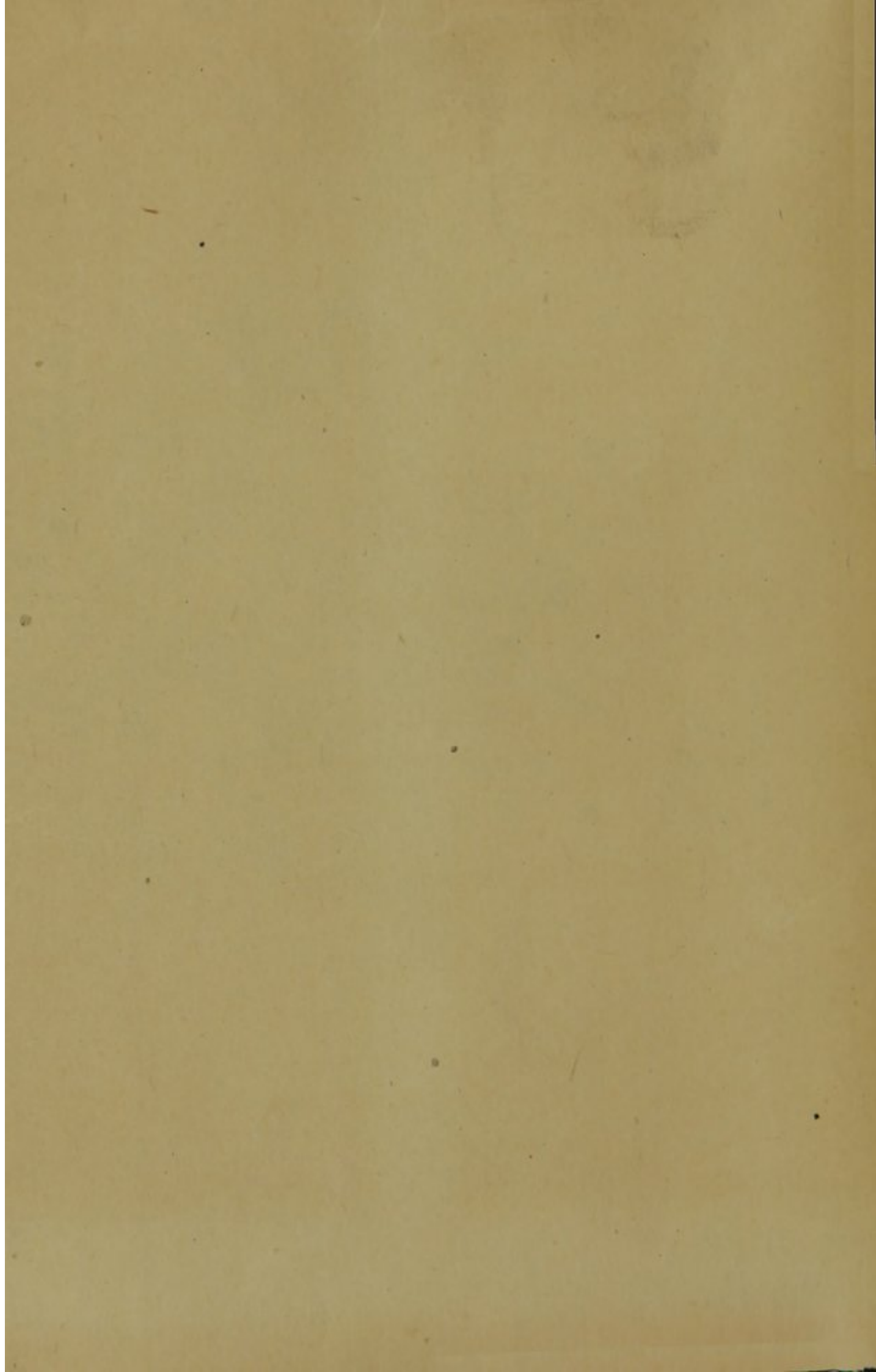
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Freel (J. G.)

Phenomena of life

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PHENOMENA OF LIFE

MAINTAINED AND CONTROLLED BY TWO ANTAGONISTIC
PRINCIPLES OF INNERVATION.

ANATOMY OF THE IRIS

REVIEWED.

VALUE OF THE IRIAN VARIATIONS IN DIAGNOSIS.

DIPHTHERIA.

Poisoning Treated on Physiological Principles.

BY J. G. FREEL, M. D.,

Associate Coroner for the United Counties of York and Peel, and
for the County of Ontario,

Stouffville, Canada West.

TORONTO:

PRINTED AT THE "CHRISTIAN GUARDIAN" OFFICE,

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JANUARY, 1884

PHYSIOLOGICAL, PATHOLOGICAL, AND THERAPEUTICAL
ACTION GOVERNED BY TWO ANTAGONISTIC PRIN-
CIPLES OR INTERVARIATION—CONSTITUTING A GEN-
ERAL LAW.

"Thus he who studies nature's laws,
From certain truths his maxims draws."

The experiments of Bernard show that on the excitation of
the superior cervical ganglion the heart is deprived of gang-

TO THE
HON. JOHN ROLPH, LL. D., M. D., M. R. C. S., ENG.,
DEAN OF THE MEDICAL FACULTY, UNIVERSITY OF
VICTORIA COLLEGE,

IN ADMIRATION OF HIS EMINENT ABILITIES AS A MEDICAL TEACHER,
THIS TREATISE IS MOST RESPECTFULLY INSCRIBED
BY THE AUTHOR.

On the other hand, that dividing the Trigeminal of the face
means it receives from the sympathetic produces innervation
dilatation of the iris and consequent contraction of the pupil.
and that division of the eye, and ultimately the destruc-
tion of the nerves of special sense follow.

These results are doubtless more suggestive of the existence
of a general law than the simple incident of the falling apple
was of a universal law of gravitation—and although the author
was not possessed of the brilliant perceptive powers of a Newton,
yet, to enable them to seize the hints and reason the world
by the promulgation of an all-important discovery, still if their
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“ Thus he who studies nature's laws,
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The experiments of Bernard show, that on the extirpation of the superior cervical ganglion, the parts thus deprived of ganglionic innervation become highly congested, with augmentation of temperature and increased sensibility. On the contrary, dividing a sensory root, produces phenomena exactly the reverse—and that by galvanizing the distal extremities of the divided nerves, the parts are instantly restored to a normal condition.

The experiments of Valentin and Longet show, that dividing the *motor oculi*, among other phenomena, produces permanent contraction of the iris, with consequent dilatation of the pupil. On the other hand, that dividing the Trigemini or the filaments it receives from the sympathetic, produces immovable dilatation of the iris, and consequent contraction of the pupil, and that disorganization of the eye, and ultimately the destruction of the nerves of special sense follow.

These results are infinitely more suggestive of the existence of a general law than the simple incident of the falling apple was of a universal law of gravitation—and although the authors were not possessed of the brilliant perceptive powers of a Newton, to enable them to seize the hints, and astound the world by the promulgation of an all-important discovery, still if their labours lead to the establishment of fixed principles, which will elevate the profession of medicine to the rank of a science, they deserve our gratitude, though their genius does not command our admiration.

The phenomena of life are maintained by two co-ordinate antagonistic systems of innervation, controlled by the cerebro-spinal, and the sympathetic centres. Nerve-fibres for the conduction of innervation to the capillaries, pass with motor fibres through the sympathetic ganglia, and possess the power of contracting the capillaries, and with sensitive fibres through the sensory ganglia, and are endowed with the special function of dilating the capillaries.

Normally, these opposing nervous forces maintain an equilibrium commensurate with the due performance of organic function, but any disturbing influence capable of producing a preponderance of either would, when transcending the boundary of health, induce disease.

Physiological action.—Experiments on the stomach of St. Martin prove, that immediately on the introduction of food the mucous membrane becomes turgid and reddened with the influx of blood, and that the gastric fluid begins at once to be secreted; but instantly on the removal of the ingesta, the membrane becomes again pale, and the secretion of the gastric fluid ceases. Here it is evident that the instantaneous sanguineous turgescence and its equally quick disappearance must be under the control of sentient principles.

The sensation produced on the sentient nerves of the mucous membrane, by the contact of the food, is communicated to their cerebro-spinal centres and an order thence transmitted along the dilating nerve-fibres, for the capillaries to expand, that the elements from which the solvent of the food is elaborated may be sufficiently supplied. But the negative sensation caused by the removal of the ingesta is conveyed by the ganglionic sensory nerve-fibres to their respective centres, and a mandate returned through the contracting nerve-fibres, for the capillaries to shut off the blood, and thus prevent an unnecessary expenditure of vital fluid. There is no doubt from the harmonious action, but when one force is in requisition that the other, being notified through an intercommunicating branch, abates its innervation.

The physiology of erection furnishes a familiar example of the operations of the Law of antagonistic innervation. The desire is communicated through the spinal column to the pudic centres, and thence reflected through the pudic nerves, to the vessels supplying the corpora cavernosa and the corpus spongiosum, and these erectile tissues become almost instantly engorged with blood, and inflexibility of the organ follows. But as soon as the ganglionic centres receive the intelligence of emission, they order the capillaries to contract and shut off the blood,—flaccidity results. Guenther says, that after the division of the pudic nerves in the horse, erection becomes impossible.

In conception we have a good illustration of the action of the dynamic forces. The instant an ovum becomes impregnated, the sentient nerves of the ovarium convey the impression to their cerebro-spinal centres, and the uterus is ordered to prepare for the reception and nourishment of the embryo. The uterine vessels enlarge and the mucous membrane becomes highly congested and immediately begins to secrete the decidua. But as soon as the fœtus is expelled and the ganglionic centres becoming sensible of the absence of the placental blood, the vessels contract and the organ soon resumes its normal condition. Connected with parturition an important practical illustration may be adduced. If the cord be tied in two places and cut between, the blood thus retained in the placenta, keeps up the impression on the sentient uterine nerves, of the continued necessity of the presence of the maternal blood, for the aeration of the fœtal, consequently the uterine vessels remain fully dilated up to the separation of the placenta. Hence the frequent “floodings” which follow this routine. Let the blood escape, and its absence being felt, the sentient uterine nerves transmit the negative impression to the ganglionic centres, and the vessels are directed to contract instantly, and, by the time the placenta is separated, excessive discharge is rarely possible.

It has been demonstrated by experiments, now more than sufficiently numerous, that the cerebro-spinal system responds to the least possible amount of excitation or sedation, while the

ganglionic system is affected only by an intensified action, and when once impressed, the influence is much more forcible and persistent.

Pathological action.—A knowledge of the law of antagonistic capillary innervation, in the treatment of disease, is all-important; for it not only affords a philosophical explanation of the morbid phenomena, but it indicates the remedies with unerring precision.

Inflammation.—That the inflammatory process is set up by a sedative influence, is manifest from the unequivocal symptoms of depression, which follow injuries, scalds, wounds, burns, the external application or internal exhibition of irritant or corrosive substances, and evident from the results of direct experiments. If the web of a frog's foot or the transparent mesentery of a warm-blooded animal, be viewed in the field of a microscope, and an irritant applied, it will be seen that contraction of the capillaries and pallidity instantly follow—and that this state continues till the shock reaches the ganglionic system and sinks its innervation below that of the cerebro-spinal, when the capillaries dilate, and the current of blood in them less rapid, and growing slower and slower till it finally becomes quiescent at the centre and begins to move from the circumference towards the stationary point, and ultimately presenting all the characteristic phenomena of inflammation.

Magendie's experiments prove beyond a doubt that direct sedation will induce inflammation. This eminent experimentalist bled healthy dogs every third day, and found that at a given time they invariably died, with all the characteristic appearances of inflammation.

Our "*antiphlogistic treatment*" has not been altogether consistent, and therefore not always satisfactory. We first take sides with the disease and hurl upon the already overwhelmed nervous centres the full force of our depleting engines, and then call to our aid the powers of a perfect Hercules and a Sampson, (opium and calomel) among excitants, to overcome the combined influence of the remedial and morbid sedation.

Fever.—All morbid agencies, which are capable of impressing the nervous centres with the essential characteristics of fever, act as direct depressants. This is obvious from the depression manifested in the symptoms of the forming stage, as well as from the universal perversion of function throughout. The cerebro-spinal centres receive the first morbid depressing influence and when the dilating force is depressed so far below the contracting as to almost stop capillary circulation, a chill is inevitable; for the calorific process of insensible combustion being carried on principally in the capillaries, it follows that the partial occlusion of these vessels, must produce not only the sensation of cold, but an actual reduction of temperature. The cold stage commences the moment morbid sedation is sufficiently intensified to take effect on the ganglionic centres, and lasts till the force of the contracting innervation is reduced below that of the dilating, when the blood, through the dilated capillaries, is sent to the surfaces in preternatural quantity and with increased velocity—ushering in the hot stage. Circulation and respiration both being increased, hæmatis must also be increased. The whole volume of blood passing more frequently through the lungs than in health, more oxygen, in a given time, must be absorbed and dissolved in the blood, and as the amount of heat evolved in combustion is always in proportion to the quantity of oxygen consumed, it follows that elevation of temperature in fever is an inevitable result.

The increase of circulation and of respiration depend on the undue stimulation of the medulla oblongata through its capillary dilatation, thus imparting a morbid *vis nervosa* to the pneumogastric.

In very rare cases, the morbid poison is so concentrated that it depresses ganglionic innervation almost instantly on its reception, and the hot stage is initiated without any appreciable premonition. On the contrary, it is possible, that the first stage be so prolonged as to produce complete occlusion of the cerebro-spinal capillaries, and "*reaction*" thus become a physical impossibility, as blood is indispensable in the generation of innervation. In intermittents, decidedly the mildest type of fever, the miasmatic influence, during the paroxysm, becomes exhausted, and consequently, the gangli-

onic force rises, and the remains of the morbidic poison, is eliminated in the profuse perspiration. A new accession of miasm is necessary for the full development of another paroxysm, and the length of time required to depress cerebro-spinal force sufficiently to induce another chill, marks the intensity of the morbidic action—quotidians being always more severe than tertians or quartans. It is but reasonable to suppose, all things being equal, that an intermission equal to the first, will be required for the development of each succeeding paroxysm.

It will be seen, by the foregoing deductions, that a very near relationship exists between fever and inflammation. This close resemblance has been so striking as to induce some pathologists to consider them identical. Both are produced by sedation, followed by a chill and ganglionic depression, with increase of temperature and sensibility. Fever is necessarily general, while inflammation is inevitably local. In the former capillary hypercæmia is simultaneously diffused throughout the whole system, while in the latter, certain nervous centres only, are depressed, and the capillaries of the tissues involved being suddenly dilated, a determination of blood, and finally active congestion, are the inevitable consequences of a hydrodynamic law.

Indications.—Excitants given in quantities sufficient to elevate the depressed ganglionic force, and thereby form a nervous equilibrium, furnish the only rational indications—*curatio contrariorum per contraria*. To hold that sedatives can possibly act as remedial agents in any case where nervous energy is already inordinately depressed, is to indorse the absurd doctrine—*similia similibus curantur*. It must be borne in mind, however, that any degree of excitation, short of elevating the ganglionic nervous force, must necessarily by stimulating dilating centres only, increase the disproportion and thereby increase the fever, while it tends, at the same time, to induce local inflammation.

Pathological conditions of the brain furnish the most brilliant illustrations of the operations of the law, as well as the most convincing proof of its importance in a scientific and practical point of view.

Nature having placed a delicate test, in the most conspicuous

position possible, which notes accurately the least disturbance of the nervous equilibrium, we have always in view, a perfect *neurometer*, to indicate the relative activity of the dynamic forces. No thermometer, however delicate, can be more sensitive to the variations of temperature, than the iris is to the changes of innervation. Whenever cerebro-spinal innervation preponderates, the iris is contracted invariably and the pupil necessarily dilated. On the contrary when ganglionic force is in the ascendant, the iris is dilated and the pupil consequently contracted. Before discussing the value of the irian variations in diagnosis, we must examine the anatomy of the structure. Is the iris really composed of circular and radiating muscular fibres? If so, on what principles can we explain the resulting phenomena from the experiments of Valentin and Langet? After cutting off the antagonistic motor power, in dividing the *motor oculi*, what remaining force could contract the radiating and at the same time dilate the circular fibres? On destroying the fifth, or its sympathetic filaments, how can we account for contraction of the circular and the dilatation of the radiating? How could intense light "*stimulate*" (?) one set to contract and *stimulate* the other, at the same time, to dilate? What explanation can be given of the facts in opium poisoning, when the circular fibres are firmly contracted, while every other muscular structure in the whole system is relaxed?

"It is not generally agreed on, whether the fibrous appearance of the iris depends on the peculiar arrangement of its vessels and nerves, or whether it possesses a true muscular structure; its functions might incline one to the latter opinion,"—*Dublin Dissector*. Thus having shown the incompatibility of such a structural arrangement with the known phenomena, the conclusion in the absence of certain anatomical knowledge, becomes irresistible, that no arrangement of the kind exists.

As the vessels and nerves converge and near the pupillary margin, they apparently coalesce, thus giving the iris the appearance of circular and radiating fibres. It is a law in vital dynamics that the increase of the diameter of an artery, causes a corresponding diminution of its length, and *vice versa*,—producing a mere change

of form but not of magnitude. The circumference of the iris being fixed by the ciliary ligament, it can only vary at its free margin floating in the aqueous humor. Hence when the vessels contract, the iris necessarily expands, and the size of the pupil is diminished. But when the vessels are dilated they are correspondingly shortened, which contracts the iris and enlarges the pupil.

The short ciliary nerves of the Lenticular ganglion supply the iris with capillary contracting innervation, while the long ciliary of the Trigeminal supply the dilating dynamic force. The Lenticular ganglion receiving its *vis nervosa* through its motor root, which is a branch of the inferior division of the *motor oculi*, it necessarily follows that the destruction of the third nerve, must also destroy the function of the short ciliary nerves, and the unopposed action of the fifth nerve, must dilate the irian vessels and enlarge the pupil. So the division of the fifth nerve, destroys the function of its long ciliary branches, and the unbalanced Lenticular innervation contracts the irian vessels and the pupil is diminished.

The destruction of the Superior Cervical ganglion cuts off sympathetic innervation from the dilating Trigeminal nerve-fibres, and thus impairs their function, while the Lenticular ganglion, being an independent centre, retains its powers undiminished, Lenticular force thus preponderating, contracts the irian vessels, and the pupil is diminished. But in all parts absolutely deprived of ganglionic innervation, the influence of the weakened Trigeminal, when thus unopposed, is still sufficient to dilate the capillaries for an indefinite period, but gradually growing less, ultimately ceases, and the tissues become atrophied. This exposition of the structure of the iris, being perfectly adapted to the rapid variations of this delicate membrane, bears the impress of truth.

Concussion.—This is a shock which first spends its influence on the cerebro-spinal centres, depressing the dilating innervation, while the ganglionic force, as yet, remaining undiminished, contracts the capillaries and thus produces anæmia of the brain—a condition incapable of sustaining volition, sensation, or perception, pupils *contracted*. This state of insensibility continues till the force of the shock reaches the ganglionic centres, and sinks the

contracting force to an equality with the dilating, when capillary circulation is resumed and consciousness returns. But the lucid period may be of short duration. Ganglionic innervation continuing to sink, soon becomes too feeble to influence the brain, and the functions of the Sensorium are again suspended. "What is true of a part is true of the whole." As the destruction of the organ of vision follows the destruction of the Superior Cervical ganglion, so the suspension of the functions of all the sympathetic ganglia suspends animation.

Diphtheria.—This disease is a perfect type of morbidic sedation, characterized by slow, feeble pulse, lividity and prostration. In no disease is the counteracting influence of excitants more clearly manifested. The chlorinated preparations are peculiarly appropriate.

Lungs.—The meshes of the capillary network are closer in those organs than in any other structure, the interspaces of lung substance being less than the capillaries themselves, and from their constant exposure to atmospheric depressing agencies are more liable to become morbidly impressed. As reduction of temperature is an indispensable prerequisite to congelation, so reduction of ganglionic innervation is a *sine qua non* to disease. Even where a phthisical predisposition is strong, tubercle cannot be developed till the nervous equilibrium is destroyed by depression. Therefore, while all unnecessary exposure and the use of all medicinal agents which tend to depress, should be scrupulously avoided, every principle calculated to exalt the vital energies, should be liberally supplied. So far has Walshe gone in this direction, as to suggest the probable prophylactic powers of excessive stimulation. Be this as it may, all experience proves, that appropriate excitation affords the only rational probability of prolonged existence.

Therapeutical action.—Exaltants are such agents as directly and continuously elevate the energies of the nervous forces. To suppose that opium, alcohol, or any other exaltant, acts first as an excitant and then as a sedative, is to propound the absurd theory of a direct reversal of the therapeutic action of the

agent, or of a reverse physiological action. Such an exposition of a natural phenomenon, requires nature to reverse her own laws, and is but a revival of the philosophy of the dark ages. According to an innate vital law, the first exalting influence is felt by the more susceptible cerebro-spinal centres—and after an interval corresponding with the potency of the agent, it excites the less impressible but more persistent and intractable ganglionic centres.

Primary phenomena.—Pupils slightly dilated—brilliancy of expression—exhilaration—skin flushed—respiration quickened—circulation accelerated—organic function increased—indisposition to sleep or repose—temporary invigoration. 2nd stage. The more forcible ganglionic system being roused, assumes the ascendancy, and the character of the symptoms is reversed. Pupils contracted to a “pin’s point”—coolness of surface—pallidity—increased perspiration—mental obtuseness—organic functions inactive—great inclination to sleep—sensibility lessened—pulse slow and full—respiratory action diminished. 3rd stage Toxical symptoms supervene—organic functions nearly suspended—deathly lividity—pulse small and frequent or imperceptible—respiration slow—occasionally convulsions, especially in children—pupils less contracted—muscles flaccid—profound insensibility—coma—death.

When a fatal termination is near, the contracting nerve-fibres which pass through the *motor oculi* to the Lenticular ganglion, become powerless; hence the less contracted state of the pupil. This symptom, therefore, must be considered almost certainly fatal.

Early in the second stage, it is barely possible that the third nerve, of one side, become paralyzed, while that of the other remains unimpaired, and thus producing the phenomenon of one pupil dilated, while the other is contracted.

All tonics and astringents are exaltants, and there is no doubt but all the metallic preparations in medicinal doses tend to elevate the vital actions, and that only when exhibited in quantities sufficient to irritate or corrode the mucous surfaces, does any of them ever produce sedation.

Exaltants cause death by producing complete occlusion of the cerebro-spinal capillaries, thus shutting off the element from which innervation is generated, when the functions of the sensorium are necessarily suspended.

Sectio cadaveris.—While the venous system is found highly congested, the capillaries are everywhere *exsanguinated*.

It is all-important to bear in mind, that in poisoning by excitation, the prostration is only apparent, nervous energy being already excessively exalted, any further stimulation must necessarily hasten the fatal issue impending.

The physiological action of electricity seems not well understood, as it is indiscriminately applied in both excitant and sedative insensibility. According to the experiments of the Webers, this agent is capable of so far contracting the small arteries as to produce complete occlusion, and is therefore wholly incompatible with the physiological condition existing in excessive excitation. Chloroform too being produced from two exceedingly prompt stimulants, possesses the concentrated activity of both, and produces anæsthesia by inducing inanition of the brain, consequently is positively contraindicated in all cases where nervous energy is already inordinately exalted.

Sedation is the only therapeutic agent capable of reducing the action of the nervous forces to a normal equilibrium; but in exhibiting Belladonna, or any other sedative, as a counter agent, the pupils must be constantly watched, and the agent discontinued the instant they begin to dilate, lest we induce the opposite extreme. In most instances when the depressant begins to affect the ganglionic system, as shown by the pupil, its influence is then sufficient to continue the depression till the nervous forces become equal. Any more than this would induce real prostration, and possibly death by exhaustion.

Sedatives.—This class embraces a wide range, extending from the least unpleasant emotion, down to agents capable of exhausting instantly ganglionic innervation.

The passage of too strong light into the interior of the eye, instead of stimulating the retina as generally held, produces a

depressing influence on the sentient fibres of the fifth nerve, which being conducted directly to the Trigeminal centre, the innervation of the long ciliary branches, is instantly repressed, and the pupil contracted. This may serve as an example of the least degree of sedation, while the action of hydrocyanic acid represents the other extreme.

The influence of sedation is felt first by the cerebro-spinal centres, the ganglionic as yet remaining unimpaired, the capillaries become contracted—but as soon as the sedation becomes sufficiently intense to affect the ganglionic system, the contracting dynamic force sinks more rapidly than the dilating, and the capillaries become expanded.

• Symptoms—1st stage—Pulse small and quick—pallidity—surface cool—mental calmness—sensibility lessened—organic functions inactive—pupils contracted.

2nd stage. Pulse slow and full—skin flushed—pupils dilated—great desire to sleep—insensible to pain—profuse perspiration—respiration slow.

3rd stage. Great prostration—pulse imperceptible—breathing at long intervals—surface cold and bathed with clammy perspiration—involuntary evacuations—pupils immovably dilated—muscles flaccid—convulsions—profound insensibility—coma—death.

Sedatives extinguish life by exhausting ganglionic innervation.

Post mortem appearances—general capillary hypercæmia.—Physiological counteracting agents. Stimulants—In great depression from whatever cause, the salutary influence of sufficiently potent excitation is truly astounding, it touches the ganglionic fountains of innervation and the convulsions cease—it reaches the sensorium and consciousness and reason return.

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