Erasmus Darwin

Zoonomia

The Laws of Organic Life

Erasmus Darwin

Zoonomia: The Laws of Organic Life

Complete Edition (Vol. 1&2)

e-artnow, 2021
Contact: info@e-artnow.org

EAN 4064066387877

Table of Contents

Volume 1

Table of Contents

PREFACE.

Table of Contents

The purport of the following pages is an endeavour to reduce the facts belonging to ANIMAL LIFE into classes, orders, genera, and species; and, by comparing them with each other, to unravel the theory of diseases. It happened, perhaps unfortunately for the inquirers into the knowledge of diseases, that other sciences had received improvement previous to their own; whence, instead of comparing the properties belonging to animated nature with each other, they, idly ingenious, busied themselves in attempting to explain the laws of life by those of mechanism and chemistry; they considered the body as an hydraulic machine, and the fluids as passing through a series of chemical changes, forgetting that animation was its essential characteristic.

The great CREATOR of all things has infinitely diversified the works of his hands, but has at the same time stamped a certain similitude on the features of nature, that demonstrates to us, that *the whole is one family of one parent*. On this similitude is founded all rational analogy; which, so long as it is concerned in comparing the essential properties of bodies, leads us to many and important discoveries; but when with licentious activity it links together objects, otherwise discordant, by some fanciful similitude; it may indeed collect ornaments for wit and poetry, but philosophy and truth recoil from its combinations.

The want of a theory, deduced from such strict analogy, to conduct the practice of medicine is lamented by its professors; for, as a great number of unconnected facts are difficult to be acquired, and to be reasoned from, the art of medicine is in many instances less efficacious under the direction of its wisest practitioners; and by that busy crowd, who either boldly wade in darkness, or are led into endless error by the glare of false theory, it is daily practised to the destruction of thousands; add to this the unceasing injury which accrues to the public by the perpetual advertisements of pretended nostrums; the minds of the indolent become superstitiously fearful of diseases, which they do not labour under; and thus become the daily prey of some crafty empyric.

A theory founded upon nature, that should bind together the scattered facts of medical knowledge, and converge into one point of view the laws of organic life, would thus on many accounts contribute to the interest of society. It would capacitate men of moderate abilities to practise the art of healing with real advantage to the public; it would enable every one of literary acquirements to distinguish the genuine disciples of medicine from those of boastful effrontery, or of wily address; and would teach mankind in some important situations the *knowledge of themselves*.

There are some modern practitioners, who declaim against medical theory in general, not considering that to think is to theorize; and that no one can direct a method of cure to a person labouring under disease without thinking, that is, without theorizing; and happy therefore is the patient, whose physician possesses the best theory.

The words idea, perception, sensation, recollection, suggestion, and association, are each of them used in this treatise in a more limited sense than in the writers of metaphysic. The author was in doubt, whether he should rather have substituted new words instead of them; but was at length of opinion, that new definitions of words already in use would be less burthensome to the memory of the reader.

A great part of this work has lain by the writer above twenty years, as some of his friends can testify: he had hoped by frequent revision to have made it more worthy the acceptance of the public; this however his other perpetual occupations have in part prevented, and may continue to prevent, as long as he may be capable of revising it; he therefore begs of the candid reader to accept of it in its present state, and to excuse any inaccuracies of expression, or of conclusion, into which the intricacy of his subject, the general imperfection of language, or the frailty he has in common with other men, may have betrayed him; and from which he has not the vanity to believe this treatise to be exempt.

Part I.

Table of Contents

SECT. I.
OF MOTION.

Table of Contents

The whole of nature may be supposed to consist of two essences or substances; one of which may be termed spirit, and the other matter. The former of these possesses the power to commence or produce motion, and the latter to receive and communicate it. So that motion, considered as a cause, immediately precedes every effect; and, considered as an effect, it immediately succeeds every cause.

The MOTIONS OF MATTER may be divided into two kinds, primary and secondary. The secondary motions are those, which are given to or received from other matter in motion. Their laws have been successfully investigated by philosophers in their treatises on mechanic powers. These motions are distinguished by this circumstance, that the velocity multiplied into the quantity of matter of the body acted upon is equal to the velocity multiplied into the quantity of matter of the acting body.

The primary motions of matter may be divided into three classes, those belonging to gravitation, to chemistry, and to life; and each class has its peculiar laws. Though these three classes include the motions of solid, liquid, and aerial bodies; there is nevertheless a fourth division of motions; I mean those of the supposed ethereal fluids of magnetism, electricity, heat, and light; whose properties are not so well investigated as to be classed with sufficient accuracy.

1st. The gravitating motions include the annual and diurnal rotation of the earth and planets, the flux and reflux of the ocean, the descent of heavy bodies, and other phænomena of gravitation. The unparalleled sagacity of the great NEWTON has deduced the laws of this class of motions from the simple principle of the general attraction of matter. These motions are distinguished by their tendency to or from the centers of the sun or planets.

2d. The chemical class of motions includes all the various appearances of chemistry. Many of the facts, which belong to these branches of science, are nicely ascertained, and elegantly classed; but their laws have not yet been developed from such simple principles as those above-mentioned; though it is probable, that they depend on the specific attractions belonging to the particles of bodies, or to the difference of the quantity of attraction belonging to the sides and angles of those particles. The chemical motions are distinguished by their being generally attended with an evident decomposition or new combination of the active materials.

3d. The third class includes all the motions of the animal and vegetable world; as well those of the vessels, which circulate their juices, and of the muscles, which perform their locomotion, as those of the organs of sense, which constitute their ideas.

This last class of motion is the subject of the following pages; which, though conscious of their many imperfections, I hope may give some pleasure to the patient reader, and contribute something to the knowledge and to the cure of diseases.

SECT. II.
EXPLANATIONS AND DEFINITIONS.

Table of Contents

* * * * *

As some explanations and definitions will be necessary in the prosecution of the work, the reader is troubled with them in this place, and is intreated to keep them in his mind as he proceeds, and to take them for granted, till an apt opportunity occurs to evince their truth; to which I shall premise a very short outline of the animal economy.

* * * * *

I.—1. The nervous system has its origin from the brain, and is distributed to every part of the body. Those nerves, which serve the senses, principally arise from that part of the brain, which is lodged in the head; and those, which serve the purposes of muscular motion, principally arise from that

part of the brain, which is lodged in the neck and back, and which is erroneously called the spinal marrow. The ultimate fibrils of these nerves terminate in the immediate organs of sense and muscular fibres, and if a ligature be put on any part of their passage from the head or spine, all motion and perception cease in the parts beneath the ligature.

2. The longitudinal muscular fibres compose the locomotive muscles, whose contractions move the bones of the limbs and trunk, to which their extremities are attached. The annular or spiral muscular fibres compose the vascular muscles, which constitute the intestinal canal, the arteries, veins, glands, and absorbent vessels.

3. The immediate organs of sense, as the retina of the eye, probably consist of moving fibrils, with a power of contraction similar to that of the larger muscles above described.

4. The cellular membrane consists of cells, which resemble those of a sponge, communicating with each other, and connecting together all the other parts of the body.

5. The arterial system consists of the aortal and the pulmonary artery, which are attended through their whole course with their correspondent veins. The pulmonary artery receives the blood from the right chamber of the heart, and carries it to the minute extensive ramifications of the lungs, where it is exposed to the action of the air on a surface equal to that of the whole external skin, through the thin moist coats of those vessels, which are spread on the air-cells, which constitute the minute terminal ramifications of the wind-pipe. Here the blood changes its colour from a dark

red to a bright scarlet. It is then collected by the branches of the pulmonary vein, and conveyed to the left chamber of the heart.

6. The aorta is another large artery, which receives the blood from the left chamber of the heart, after it has been thus aerated in the lungs, and conveys it by ascending and descending branches to every other part of the system; the extremities of this artery terminate either in glands, as the salivary glands, lacrymal glands, &c. or in capillary vessels, which are probably less involuted glands; in these some fluid, as saliva, tears, perspiration, are separated from the blood; and the remainder of the blood is absorbed or drank up by branches of veins correspondent to the branches of the artery; which are furnished with valves to prevent its return; and is thus carried back, after having again changed its colour to a dark red, to the right chamber of the heart. The circulation of the blood in the liver differs from this general system; for the veins which drink up the refluent blood from those arteries, which are spread on the bowels and mesentery, unite into a trunk in the liver, and form a kind of artery, which is branched into the whole substance of the liver, and is called the vena portarum; and from which the bile is separated by the numerous hepatic glands, which constitute that viscus.

7. The glands may be divided into three systems, the convoluted glands, such as those above described, which separate bile, tears, saliva, &c. Secondly, the glands without convolution, as the capillary vessels, which unite the terminations of the arteries and veins; and separate both the mucus, which lubricates the cellular membrane, and the

perspirable matter, which preserves the skin moist and flexible. And thirdly, the whole absorbent system, consisting of the lacteals, which open their mouths into the stomach and intestines, and of the lymphatics, which open their mouths on the external surface of the body, and on the internal linings of all the cells of the cellular membrane, and other cavities of the body.

These lacteal and lymphatic vessels are furnished with numerous valves to prevent the return of the fluids, which they absorb, and terminate in glands, called lymphatic glands, and may hence be considered as long necks or mouths belonging to these glands. To these they convey the chyle and mucus, with a part of the perspirable matter, and atmospheric moisture; all which, after having passed through these glands, and having suffered some change in them, are carried forward into the blood, and supply perpetual nourishment to the system, or replace its hourly waste.

8. The stomach and intestinal canal have a constant vermicular motion, which carries forwards their contents, after the lacteals have drank up the chyle from them; and which is excited into action by the stimulus of the aliment we swallow, but which becomes occasionally inverted or retrograde, as in vomiting, and in the iliac passion.

II. 1. The word *sensorium* in the following pages is designed to express not only the medullary part of the brain, spinal marrow, nerves, organs of sense, and of the muscles; but also at the same time that living principle, or spirit of animation, which resides throughout the body, without being cognizable to our senses, except by its

effects. The changes which occasionally take place in the sensorium, as during the exertions of volition, or the sensations of pleasure or pain, are termed *sensorial motions*.

2. The similarity of the texture of the brain to that of the pancreas, and some other glands of the body, has induced the inquirers into this subject to believe, that a fluid, perhaps much more subtile than the electric aura, is separated from the blood by that organ for the purposes of motion and sensation. When we recollect, that the electric fluid itself is actually accumulated and given out voluntarily by the torpedo and the gymnotus electricus, that an electric shock will frequently stimulate into motion a paralytic limb, and lastly that it needs no perceptible tubes to convey it, this opinion seems not without probability; and the singular figure of the brain and nervous system seems well adapted to distribute it over every part of the body.

For the medullary substance of the brain not only occupies the cavities of the head and spine, but passes along the innumerable ramifications of the nerves to the various muscles and organs of sense. In these it lays aside its coverings, and is intermixed with the slender fibres, which constitute those muscles and organs of sense. Thus all these distant ramifications of the sensorium are united at one of their extremities, that is, in the head and spine; and thus these central parts of the sensorium constitute a communication between all the organs of sense and muscles.

3. A *nerve* is a continuation of the medullary substance of the brain from the head or spine towards the other parts

of the body, wrapped in its proper membrane.

4. The *muscular fibres* are moving organs intermixed with that medullary substance, which is continued along the nerves, as mentioned above. They are indued with the power of contraction, and are again elongated either by antagonist muscles, by circulating fluids, or by elastic ligaments. So the muscles on one side of the forearm bend the fingers by means of their tendons, and those on the other side of the fore-arm extend them again. The arteries are distended by the circulating blood; and in the necks of quadrupeds there is a strong elastic ligament, which assists the muscles, which elevate the head, to keep it in its horizontal position, and to raise it after it has been depressed.

5. The *immediate organs of sense* consist in like manner of moving fibres enveloped in the medullary substance above mentioned; and are erroneously supposed to be simply an expansion of the nervous medulla, as the retina of the eye, and the rete mucosum of the skin, which are the immediate organs of vision, and of touch. Hence when we speak of the contractions of the fibrous parts of the body, we shall mean both the contractions of the muscles, and those of the immediate organs of sense. These *fibrous motions* are thus distinguished from the *sensorial motions* above mentioned.

6. The *external organs* of sense are the coverings of the immediate organs of sense, and are mechanically adapted for the reception or transmission of peculiar bodies, or of their qualities, as the cornea and humours of the eye, the tympanum of the ear, the cuticle of the fingers and tongue.

7. The word *idea* has various meanings in the writers of metaphysic: it is here used simply for those notions of external things, which our organs of sense bring us acquainted with originally; and is defined a contraction, or motion, or configuration, of the fibres, which constitute the immediate organ of sense; which will be explained at large in another part of the work. Synonymous with the word idea, we shall sometimes use the words *sensual motion* in contradistinction to *muscular motion*.

8. The word *perception* includes both the action of the organ of sense in consequence of the impact of external objects, and our attention to that action; that is, it expresses both the motion of the organ of sense, or idea, and the pain or pleasure that succeeds or accompanies it.

9. The pleasure or pain which necessarily accompanies all those perceptions or ideas which we attend to, either gradually subsides, or is succeeded by other fibrous motions. In the latter case it is termed *sensation*, as explained in Sect. V. 2, and VI. 2.—The reader is intreated to keep this in his mind, that through all this treatise the word sensation is used to express pleasure or pain only in its active state, by whatever means it is introduced into the system, without any reference to the stimulation of external objects.

10. The vulgar use of the word *memory* is too unlimited for our purpose: those ideas which we voluntarily recall are here termed ideas of *recollection*, as when we will to repeat the alphabet backwards. And those ideas which are suggested to us by preceding ideas are here termed ideas of *suggestion*, as whilst we repeat the alphabet in the usual

order; when by habits previously acquired B is suggested by A, and C by B, without any effort of deliberation.

11. The word *association* properly signifies a society or convention of things in some respects similar to each other. We never say in common language, that the effect is associated with the cause, though they necessarily accompany or succeed each other. Thus the contractions of our muscles and organs of sense may be said to be associated together, but cannot with propriety be said to be associated with irritations, or with volition, or with sensation; because they are caused by them, as mentioned in Sect. IV. When fibrous contractions succeed other fibrous contractions, the connection is termed *association*; when fibrous contractions succeed sensorial motions, the connection is termed *causation*; when fibrous and sensorial motions reciprocally introduce each other in progressive trains or tribes, it is termed *catenation* of animal motions. All these connections are said to be produced by *habit*; that is, by frequent repetition.

12. It may be proper to observe, that by the unavoidable idiom of our language the ideas of perception, of recollection, or of imagination, in the plural number signify the ideas belonging to perception, to recollection, or to imagination; whilst the idea of perception, of recollection, or of imagination, in the singular number is used for what is termed "a reflex idea of any of those operations of the sensorium."

13. By the word *stimulus* is not only meant the application of external bodies to our organs of sense and muscular fibres, which excites into action the sensorial

power termed irritation; but also pleasure or pain, when they excite into action the sensorial power termed sensation; and desire or aversion, when they excite into action the power of volition; and lastly, the fibrous contractions which precede association; as is further explained in Sect. XII. 2. 1.

SECT. III.
THE MOTIONS OF THE RETINA DEMONSTRATED BY EXPERIMENTS.

Table of Contents

I. *Of animal motions and of ideas.* II. *The fibrous structure of the retina.* III. *The activity of the retina in vision.* 1. *Rays of light have no momentum.* 2. *Objects long viewed become fainter.* 3. *Spectra of black objects become luminous.* 4. *Varying spectra from gyration.* 5. *From long inspection of various colours.* IV. *Motions of the organs of sense constitute ideas.* 1. *Light from pressing the eye-ball, and sound from the pulsation of the carotid artery.* 2. *Ideas in sleep mistaken for perceptions.* 3. *Ideas of imagination produce pain and sickness like sensations.* 4. *When the organ of sense is destroyed, the ideas belonging to that sense perish.* V. *Analogy between muscular motions and sensual motions, or ideas.* 1. *They are both originally excited by irritations.* 2. *And associated together in the same manner.* 3. *Both act in nearly the same times.* 4. *Are alike strengthened or fatigued by exercise.* 5. *Are alike painful from inflammation.* 6. *Are alike benumbed by compression.* 7. *Are alike liable to paralysis.* 8. *To convulsion.* 9. *To the influence of old age.*—VI. *Objections answered.* 1. *Why we cannot invent new ideas.* 2. *If ideas resemble external objects.* 3. *Of the imagined sensation in an*

amputated limb. 4. *Abstract ideas.*—VII. *What are ideas, if they are not animal motions?*

Before the great variety of animal motions can be duly arranged into natural classes and orders, it is necessary to smooth the way to this yet unconquered field of science, by removing some obstacles which thwart our passage. I. To demonstrate that the retina and other immediate organs of sense possess a power of motion, and that these motions constitute our ideas, according to the fifth and seventh of the preceding assertions, claims our first attention.

Animal motions are distinguished from the communicated motions, mentioned in the first section, as they have no mechanical proportion to their cause; for the goad of a spur on the skin of a horse shall induce him to move a load of hay. They differ from the gravitating motions there mentioned as they are exerted with equal facility in all directions, and they differ from the chemical class of motions, because no apparent decompositions or new combinations are produced in the moving materials.

Hence, when we say animal motion is excited by irritation, we do not mean that the motion bears any proportion to the mechanical impulse of the stimulus; nor that it is affected by the general gravitation of the two bodies; nor by their chemical properties, but solely that certain animal fibres are excited into action by something external to the moving organ.

In this sense the stimulus of the blood produces the contractions of the heart; and the substances we take into our stomach and bowels stimulate them to perform their necessary functions. The rays of light excite the retina into

animal motion by their stimulus; at the same time that those rays of light themselves are physically converged to a focus by the inactive humours of the eye. The vibrations of the air stimulate the auditory nerve into animal action; while it is probable that the tympanum of the ear at the same time undergoes a mechanical vibration.

To render this circumstance more easy to be comprehended, *motion may be defined to be a variation of figure*; for the whole universe may be considered as one thing possessing a certain figure; the motions of any of its parts are a variation of this figure of the whole: this definition of motion will be further explained in Section XIV. 2. 2. on the production of ideas.

Now the motions of an organ of sense are a succession of configurations of that organ; these configurations succeed each other quicker or slower; and whatever configuration of this organ of sense, that is, whatever portion of the motion of it is, or has usually been, attended to, constitutes an idea. Hence the configuration is not to be considered as an effect of the motion of the organ, but rather as a part or temporary termination of it; and that, whether a pause succeeds it, or a new configuration immediately takes place. Thus when a succession of moving objects are presented to our view, the ideas of trumpets, horns, lords and ladies, trains and canopies, are configurations, that is, parts or links of the successive motions of the organ of vision.

Plate I.

These motions or configurations of the organs of sense differ from the sensorial motions to be described hereafter, as they appear to be simply contractions of the fibrous extremities of those organs, and in that respect exactly resemble the motions or contractions of the larger muscles, as appears from the following experiment. Place a circular piece of red silk about an inch in diameter on a sheet of white paper in a strong light, as in Plate I.—look for a minute on this area, or till the eye becomes somewhat fatigued, and then, gently closing your eyes, and shading them with your hand, a circular green area of the same apparent diameter becomes visible in the closed eye. This green area is the colour reverse to the red area, which had been previously inspected, as explained in the experiments on ocular spectra at the end of the work, and in Botanical Garden, P. 1. additional note, No. 1. Hence it appears, that a part of the retina, which had been fatigued by contraction in one direction, relieves itself by exerting the antagonist fibres, and producing a contraction in an opposite direction, as is common in the exertions of our muscles. Thus when we are tired with long action of our arms in one direction, as in

holding a bridle on a journey, we occasionally throw them into an opposite position to relieve the fatigued muscles.

Mr. Locke has defined an idea to be "whatever is present to the mind;" but this would include the exertions of volition, and the sensations of pleasure and pain, as well as those operations of our system, which acquaint us with external objects; and is therefore too unlimited for our purpose. Mr. Lock seems to have fallen into a further error, by conceiving, that the mind could form a general or abstract idea by its own operation, which was the copy of no particular perception; as of a triangle in general, that was neither acute, obtuse, nor right angled. The ingenious Dr. Berkley and Mr. Hume have demonstrated, that such general ideas have no existence in nature, not even in the mind of their celebrated inventor. We shall therefore take for granted at present, that our recollection or imagination of external objects consists of a partial repetition of the perceptions, which were excited by those external objects, at the time we became acquainted with them; and that our reflex ideas of the operations of our minds are partial repetitions of those operations.

II. The following article evinces that the organ of vision consists of a fibrous part as well as of the nervous medulla, like other white muscles; and hence, as it resembles the muscular parts of the body in its structure, we may conclude, that it must resemble them in possessing a power of being excited into animal motion.—The subsequent experiments on the optic nerve, and on the colours remaining in the eye, are copied from a paper on ocular spectra published in the seventy-sixth volume of the Philos.

Trans. by Dr. R. Darwin of Shrewsbury; which, as I shall have frequent occasion to refer to, is reprinted in this work, Sect. XL. The retina of an ox's eye was suspended in a glass of warm water, and forcibly torn in a few places; the edges of these parts appeared jagged and hairy, and did not contract and become smooth like simple mucus, when it is distended till it breaks; which evinced that it consisted of fibres. This fibrous construction became still more distinct to the light by adding some caustic alcali to the water; as the adhering mucus was first eroded, and the hair-like fibres remained floating in the vessel. Nor does the degree of transparency of the retina invalidate this evidence of its fibrous structure, since Leeuwenhoek has shewn, that the crystalline humour itself consists of fibres. Arc. Nat. V. I. 70.

Hence it appears, that as the muscles consist of larger fibres intermixed with a smaller quantity of nervous medulla, the organ of vision consists of a greater quantity of nervous medulla intermixed with smaller fibres. It is probable that the locomotive muscles of microscopic animals may have greater tenuity than these of the retina; and there is reason to conclude from analogy, that the other immediate organs of sense, as the portio mollis of the auditory nerve, and the rete mucosum of the skin, possess a similarity of structure with the retina, and a similar power of being excited into animal motion.

III. The subsequent articles shew, that neither mechanical impressions, nor chemical combinations of light, but that the animal activity of the retina constitutes vision.

1. Much has been conjectured by philosophers about the momentum of the rays of light; to subject this to experiment

a very light horizontal balance was constructed by Mr. Michel, with about an inch square of thin leaf-copper suspended at each end of it, as described in Dr. Priestley's History of Light and Colours. The focus of a very large convex mirror was thrown by Dr. Powel, in his lectures on experimental philosophy, in my presence, on one wing of this delicate balance, and it receded from the light; thrown on the other wing, it approached towards the light, and this repeatedly; so that no sensible impulse could be observed, but what might well be ascribed to the ascent of heated air.

Whence it is reasonable to conclude, that the light of the day must be much too weak in its dilute state to make any mechanical impression on so tenacious a substance as the retina of the eye.—Add to this, that as the retina is nearly transparent, it could therefore make less resistance to the mechanical impulse of light; which, according, to the observations related by Mr. Melvil in the Edinburgh Literary Essays, only communicates heat, and should therefore only communicate momentum, where it is obstructed, reflected, or refracted.—From whence also may be collected the final cause of this degree of transparency of the retina, viz. left by the focus of stronger lights, heat and pain should have been produced in the retina, instead of that stimulus which excites it into animal motion.

2. On looking long on an area of scarlet silk of about an inch in diameter laid on white paper, as in Plate I. the scarlet colour becomes fainter, till at length it entirely vanishes, though the eye is kept uniformly and steadily upon it. Now if the change or motion of the retina was a mechanical impression, or a chemical tinge of coloured

light, the perception would every minute become stronger and stronger—whereas in this experiment it becomes every instant weaker and weaker. The same circumstance obtains in the continued application of sound, or of sapid bodies, or of odorous ones, or of tangible ones, to their adapted organs of sense.

Plate II.

Thus when a circular coin, as a shilling, is pressed on the palm of the hand, the sense of touch is mechanically compressed; but it is the stimulus of this pressure that excites the organ of touch into animal action, which constitutes the perception of hardness and of figure; for in some minutes the perception ceases, though the mechanical pressure of the object remains.

3. Make with ink on white paper a very black spot about half an inch in diameter, with a tail about an inch in length, so as to resemble a tadpole, as in Plate II.; look steadfastly for a minute on the center of this spot, and, on moving the eye a little, the figure of the tadpole will be seen on the white part of the paper; which figure of the tadpole will appear more luminous than the other part of the white paper; which can only be explained by supposing that a part

of the retina, on which the tadpole was delineated, to have become more sensible to light than the other parts of it, which were exposed to the white paper; and not from any idea of mechanical impression or chemical combination of light with the retina.

4. When any one turns round rapidly, till he becomes dizzy, and falls upon the ground, the spectra of the ambient objects continue to present themselves in rotation, and he seems to behold the objects still in motion. Now if these spectra were impressions on a passive organ, they either must continue as they were received last, or not continue at all.

5. Place a piece of red silk about an inch in diameter on a sheet of white paper in a strong light, as in Plate I; look steadily upon it from the distance of about half a yard for a minute; then closing your eye-lids, cover them with your hands and handkerchief, and a green spectrum will be seen in your eyes resembling in form the piece of red silk. After some seconds of time the spectrum will disappear, and in a few more seconds will reappear; and thus alternately three or four times, if the experiment be well made, till at length it vanishes entirely.