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they who believe it will endure no error." That Reinhard strenuously insisted on the atonement by a divine Saviour, and on faith in it as the indispensable condition of salvation, his discourses furnish abundant evidence. The longer he lived, so much the more evangelical became his style of address. His later sermons have less of the distinctively ethical, and more of the strictly religious character. His errors were those which the circumstances in which he wrote, would naturally incline him to adopt; and instead of complaining that he did not cordially defend some truths which we prize, we should rather be grateful that he emerged from the spiritual darkness of his age, and stood forth the champion of a down-trodden and essentially evangelical creed.

ARTICLE VII.

OF THE DEPENDENCE OF THE MENTAL POWERS UPON THE BODILY ORGANIZATION.

By George I. Chace, Prof. of Chemistry and Geology in Brown University.

FEW subjects are fitted to awaken a more lively interest, than the mysterious connection subsisting between the body and the spirit. Though entirely distinct from one another, and constituted, as there is reason to believe, of essentially different elements, they are bound together by the closest ties, and sustain throughout the most intimate relations. Neither is able to withdraw itself from the other, or can act independently of the other, or has any power except through the other. Any disorder of the body immediately affects the mind, and any derangement of the mind as quickly extends its influence to the body. This wonderful union, and, as it would almost seem, blending of the material and spiritual in our natures, has commonly been regarded rather as a theme for the exercise of the imagination and fancy, than as a subject for sober investigation; and the ideas formed concerning it have been expressed more frequently in the vague and figurative language of poetry, than in the precise terms of philosophy. They have moreover been as various as the different aspects of the connection to which they relate.

Some of the ancients looked upon the complex frame of mind and body as a kind of musical instrument, and regarded the different nerves as so many keys to whose mysterious touch the soul gives out

its beautiful harmonies. Others saw in the body a prison, in which the spirit is incarcerated, and from which it can look out upon the world only through the narrow windows of the senses. But for the barrier opposed by the dark walls, which shut it in on every side, they supposed the range of its perceptions and knowledge would be much wider. Remove that, and the soul would be all eye, and all ear, and the intellect pure intelligence. In the Second epistle of Paul to the Corinthians, and in the General epistle of Peter, we find the body spoken of under the figure of a tabernacle or house, fitted up indeed with various accommodations for the temporary residence of the spirit, but destined after a few years to be exchanged for a more glorious habitation, "a house not made with hands, eternal in the heavens." In later times, since the structure and functions of the several parts of the bodily frame have been better understood, it has more commonly been regarded as a very complex machine, embracing numerous contrivances, adapting it on the one hand, to the powers and susceptibilities of spirit, and on the other, to the endowments and capacities of matter—a specially constituted medium through which these two forms of being, although in nature so widely removed from one another, may notwithstanding hold intercourse—a skilfully constructed instrument whereby the soul is enabled to impress its volitions upon outward existences, and these in turn can act upon the soul.

Within a few years past, there have arisen those who suppose, that besides establishing a communication between the mind and the external world, the body also furnishes in the brain, organs through which the different mental powers are exercised. They believe that not only the intellectual faculties, but also the sentiments are dependent in their manifestation upon these organs, in the same manner as the several bodily functions are dependent upon the parts respectively ministering to them; and as in the latter case, they imagine the vigor of these faculties and sentiments to be proportional to the development of the particular regions of the brain, with which their manifestation is connected, and moreover capable of being determined by the external indications of such development.

Without stopping to inquire how much of truth there may be in these or any other ideas that have been advanced in respect to the relation subsisting between the spiritual and the corporeal nature of man, we propose to trace the organic conditions of the several classes of mental phenomena so far as it may be done in the present state of physiological science, and see what light these throw upon the subject. We shall commence with the phenomena which are most immediately and most obviously connected with the body—the various forms of

sensation. All of these, of whatever character they may be, whether pleasurable or painful, whether designed for the protection of the body or for the conveying of information to the mind, are directly dependent upon the nervous system, the only part of the organization in immediate relation to the spirit—the only part upon which the spirit is capable of acting, or through which it can receive impressions from the outward world. The connection of the other parts is solely through this. By themselves, the bones, muscles, and integuments, the organs of the several senses, the heart, lungs and stomach have no more life, no more sensibility, no more power of motion than any foreign matter. It is the nerves alone that endow them with these properties—that put them in communication with the spirit, and thus render them available for the different purposes which they are designed to accomplish in the living economy. In prosecuting an inquiry, therefore, designed to throw light upon the organic conditions of the mental phenomena, we need not extend our researches beyond the nervous system, as all without this is necessarily excluded from any direct agency in their production.

All our sensations, have their remote origin in impressions made upon the outward senses. These impressions, however they may be produced, whether by the contact of solid bodies or by the vibration of aeriform fluids or by the impulses or undulations of still more subtle media, give rise to some kind of action—its precise nature has not been determined—which is propagated along the filaments of the nerves, until arriving at their termination in the brain, it passes to the spirit. By a law of our constitution, the sensations thus awakened although really in the mind, are referred either to the parts of the body where the impressions in which they originate are made, or else to the external objects which are the cause of these impressions. Such a reference of them is necessary in order that they may accomplish the objects for which they are intended—the protection of the body and the imparting of knowledge to the mind. Did not the pain occasioned by too great heat or too great cold or by undue pressure or by any of the other causes from which we are liable to suffer, direct our attention to the part affected, it would be of little service in enabling us to avoid the threatened injury. The same is true of the suffering attendant on disease. Did we conceive of this, only as an affection of the spirit, it would afford no indication as to the nature or situation of the disorder, and no guide as to the proper means for remedying it. The sensations connected with the eye and ear, on the other hand, being designed for the sole purpose of awakening in the mind a knowledge of external existences, are uniformly referred to objects without ourselves.

The different shades of color, whether from instinct or through the power of habit formed at a period too early for its origin to leave traces in the memory, are constantly regarded by us as attributes of the bodies which reflect the rays immediately producing them. Nay, we necessarily conceive of them not only as external to ourselves, but as having actual extension—as spread over the surface of those bodies, in the same way as the sensations designed to protect our corporeal frames seem to extend through the parts in which we imagine them to be situated. And yet, it is obvious upon a moment's reflection, that no two things can be more unlike than the state or affection of the spirit produced by the impinging of the different colored rays upon the optic nerve, and that physical condition of the surface of bodies which determines the reflection of those rays. They are as wholly dissimilar as the sensation of heat, and the substance which evolves the calorific producing it; or as the sensations of smell and the bodies which exhale the odors awakening them; or as those of touch and the material forms whose contact and pressure excite them. The same general observations apply to the ear. The sensations which we experience through this organ seem to be wafted from the distant body whose vibratory movements, propagated through the intervening air, are the immediate agent in their production. Neither the distant body, however, nor the atmospheric undulations proceeding from it, bear any resemblance to sound. • This, like color, is merely a sensation in the mind, which from long habit we have come to associate so closely with its outward cause, that we cannot even in imagination separate them. In a similar way, "up," and its correlative "down," although relating exclusively to the earth, and in reality changing in direction each moment as that turns upon its axis, have become so intimately connected with our notion of space, that we cannot wholly exclude them, even when we endeavor to form the most absolute and unbounded conception of space, which our limited faculties will permit.

It might be supposed that the apparently local character of our bodily sensations, instead of being the result of a direct constitutional provision, is only the natural consequence of an extension of the sentient principle along the innumerable ramifications of the nerves to every part of the entire frame. Such an explanation, however, would not apply to the case of color and sound, which though equally sensations, we uniformly regard as the attributes of bodies situated wholly without and beyond ourselves. The supposition is moreover directly at variance with the teachings of observation and experiment. These show that the brain is the only part of the nervous system in immediate relation to the spirit. The other and remoter parts have their con-

nection with it, through this. If a nerve of sensation be cut, it immediately loses its sensibility. So long as the parts remain separate, the paralysis continues; but when at length nature has effected their re-union, the nerve resumes its wonted properties. By a like separation from the great central organ of all the animal functions, the nerves of voluntary motion are equally disqualified for their proper office, and while the isolation continues, have no more power over the muscles to which they go, than so many threads of any foreign substance. Even the spinal marrow, which from its near resemblance to the brain in composition and structure might be supposed to perform a similar office, in ministering to sensation and voluntary motion serves only as a medium of communication between that and the remoter portions of the nervous system. When it is so far disordered at any point as to cause an interruption of the peculiar action that is propagated along it or the peculiar fluid which is transmitted through it, all the nerves that pass off below that point become paralyzed, and the several parts of the body to which they are distributed lose both their sensibility and their power of motion. By a careful and delicate dissection moreover, the nervous filaments, or rather tubes as they appear when examined by the aid of the microscope, may be traced from the extremities through this organ up to the brain.

As a further proof that the local reference of our bodily sensations is due to a special organic provision, and not to a general diffusion of the sentient principle, it may be remarked that we do not always conceive of the pain attendant on injury and disease, as situated in the affected part. If a nerve going to the hand or the foot be irritated, the annoyance and suffering experienced are not felt at the point of irritation, but in the hand or foot where the nerve terminates. Every one is acquainted with the sensation produced in the little finger and along the inner edge of the forearm, by a blow on the ulnar nerve where it passes over the elbow. In the same way, the pain experienced after an amputation, from the irritated and inflamed state of the large nervous trunks severed in the operation, continues to be referred by the individual to the removed limb, until the painful certainty of its loss continually forced upon him by his other senses has at length broken up the association. So also after the rhinoplastic operation, performed by detaching, bringing down, and twisting over a portion of the skin of the forehead, until the edges of the flap have become united by vascular and nervous connections to the skin of the face, the sensations caused by touching the new organ are still referred to the forehead. It is well known that tumors generally give rise by their pressure upon adjacent nerves to sensations of uneasiness and

suffering in parts quite remote from where they are situated. Indeed, a large proportion of what are usually denominated sympathetic pains, receive their explanation from this same organic law, in consequence of which the sensations produced by the irritation of a nerve at any point in its course, are uniformly referred to the part or parts where the branches of that nerve terminate.

It deserves further to be remarked in this connection, that each nerve is so constituted as to be capable of awakening but a single class of sensations. The optic nerve, whatever the stimulus applied to it, can awaken only sensations of color. No pain is occasioned by its mechanical irritation; there is no consciousness even of such irritation; all that the individual perceives, is a succession of luminous flashes of greater or less vividness. The effect is the same when discharges of electricity are made to take place along its fibres. By pressure properly applied to the ball of the eye and through that to the nerve, all the colors of the rainbow may be produced. Even gastric disturbance, when extending its influence to this organ, awakens only the perception of brilliant luminous points and spectra. So also the auditory nerve is capable of exciting no other sensations than those of sound. Irritation or pressure communicated to it through the surrounding parts, does not occasion pain but simply *tinnitus aurium*, or ringing in the ears; and as the passage of electricity along the optic nerve produces an effect nearly resembling lightning; so the transmission of the same fluid along the auditory nerve awakens a sensation that might be mistaken for thunder. The same is true of the nerves of smell, of taste, and of feeling. Each of these is precisely fitted in all respects for the performance of its own proper office, but no one of them is capable of performing under any circumstances the office of another. As well might the elements themselves interchange their respective functions and properties.

We next pass to a brief review of the phenomena of perception. These, though less immediately perhaps, are as really dependent upon the action of the brain and nerves, as those of sensation. In fact, there is reason to believe that they are always either preceded, or attended by sensation, and are consequently subject in their manifestation to the same organic laws. They are commonly divided by writers on mental philosophy into two classes; the first, including all our original perceptions, or those which are supposed to have been connected with the first use of our perceptive faculties, and the second and far more numerous class embracing all those ideas which though not originally derived from the senses, have become through the power of habit, indissolubly associated with their exercise. The dis-

tion is undoubtedly a just one, and should be borne in mind, if we would form correct views in regard to the sources of our knowledge. For, while on the one hand, it would seem clear that if our sensations had originally suggested nothing beyond themselves, they must forever have remained thus isolated, on the other hand it is equally clear, that a very large proportion of the ideas, which they at present serve to introduce, are connected with them only by the ties of association. For the true origin of these, we must look to other classes of sensations, or to the deductions of reason, or to the teachings of experience, or to all of these different sources combined. Of the numerous and varied perceptions which we now have through the eye, it is probable that only those of color and figure and the latter with but two dimensions, first entered the mind through that organ. All the others, whether of form, size and distance, or of the numerous physical conditions and properties of bodies, so instantly recognized by their appearance, have been gradually built up upon these. Although in reality only associated conceptions, they are suggested so immediately and held before the mind so steadily, that we ordinarily mistake their character and confound them with our perceptions. By a careful analysis, however, of the assemblage of ideas called up by looking at any familiar object, it is not difficult to distinguish them; and in endeavoring to do so, we may derive assistance from recollecting that the same ideas are awakened by the picture of that object, which consists of nothing but different shades of color spread upon a plane surface. That a large part of the information received at present through the eye, entered the mind originally through other channels, is more-over evident from what we know of those persons who have seen for the first time after they have arrived at an age enabling them to notice and describe their sensations. Such persons have been found uniformly unable to recognize by sight the objects, with which they were most familiar through the other senses; and it has been only by a long course of experience that they have learned to connect the perceptions which they have through their newly acquired faculty with the corresponding ones of touch, so as to refer both to the same external object. The boy who was couched by Cheselden, at first saw everything flat. The walls of the room, the beams projecting from them, and even the intervening articles of furniture, seemed to be in the same plane; nor could he distinguish from one another, by their appearance, the objects immediately around him, which he had known and been accustomed to handle from his infancy. "He was acquainted with a dog and cat *by feeling*, but could not remember their respective characters when he *saw* them. One day when thus puzzled,

he took up the cat in his arms and felt her attentively, so as to associate the two sets of ideas; and then setting her down, said, 'so, puss, I shall know you another time.' " Dr. Wm. B. Carpenter, in his excellent treatise on physiology, mentions the case of a boy upon whom he operated, and who for some time after he had acquired the power of seeing, was accustomed when in haste and among familiar objects to close his eyes, so little was the assistance derived from them, and direct his steps by feeling.

To draw the precise line of distinction between our original and our acquired perceptions, and to trace each of the latter to its true source, is one of the most difficult tasks of the mental philosopher; and as it is in no way essential to the proper elucidation of our subject, we do not propose to enter upon it. We would rather invite the attention of the reader to a brief consideration of the feature of the human constitution, in which this association of ideas,—this blending of the knowledge derived from one sense with the perceptions awakened through another, has its origin. On examination, it will be found to proceed, we think, from a law of our nature which may be expressed as follows. Whenever any two bodily or mental acts have been many times performed either simultaneously or successively, the repetition of one of these acts creates a tendency towards the other; and so strong does the tie between the two at length become, that the performance of one is invariably accompanied or followed by that of the other, without any conscious effort on our part. This law, which would seem also to hold, though not perhaps to so great an extent, of the bodily and mental affections or states, lies at the foundation of all our habits. Without it, indeed, we should be wholly incapable of habit, that chief method and instrument of every form of human improvement. Without this we should be unable to fit ourselves for any of the avocations or duties of life. We could not learn to act or to think, to talk or to walk. We could not rise in the scale of existence even to a level with the brutes, many of which are to a certain extent susceptible of education. Nay, we should be incapable of making provision for the supply of our natural wants, and the race itself would become extinct.

Illustrations of this great and fundamental law of our nature, may be drawn from any of the trades, arts, professions or occupations in which men are engaged. Preparation for them, consists not so much in the acquisition of knowledge as in the formation of habits. It is not the committing of rules or the understanding of principles even, but practice that makes perfect. He who would learn to play upon a musical instrument, will find the most difficult part of his task to con-

sist in chaining together the varied muscular contractions necessary for the execution of an air, so that when the first movement has been made, the others shall spontaneously follow, with due regard to order and time. When this point has at length been attained, he may withdraw his immediate attention from the instrument and become interested in other subjects, and engage in conversation upon them, and the keys continue to be rightly touched, and the harmonies to flow on. In learning to speak a language, the chief labor consists, not in mastering its vocabulary, nor yet in acquiring a knowledge of the laws in accordance with which its words are combined in the construction of sentences, but in linking them to the corresponding ideas, so that these on arising in the mind shall instantly suggest them, and in forming the organs of articulation to those habits of associated action which are necessary to their ready and fluent utterance. So also in the different kinds of mental training, the most important as well as the most difficult end to be attained, is not the acquisition of knowledge, but the power of using it—not the simple storing of the mind with ideas, but the connecting of these ideas with one another according to their natural relations, so that they shall spontaneously flow out in continuous trains of just and vigorous thought; and this concatenation can be effected only by causing them repeatedly to pass through the mind in the order or orders in which we would have them associated.

We are aware that writers on this subject are accustomed to speak of contiguity of time and place, of the relations of cause and effect, of resemblance and of contrast, as principles of association; and that our ideas are connected with one another very generally in accordance with these relations, is unquestionably true. But, that these relations constitute the real tie between them and are the immediate cause of that connection, is a very different and we think far more doubtful proposition. Indeed, such a notion can be founded only on the supposition that our ideas are actual existences stored away in the mind and so chained together by certain constitutional affinities, that when any one of them is brought under review, it draws the others along after it. The moment we conceive of them in their true character, as states or affections of the spirit, having their origin either in its own action or in that of the organism with which it is connected, we see that like all other effects, they can be associated only through the causes which produce them. The real, physical connection must exist between these, and if we mistake not, is to be found in those ties which habit has established among the different bodily and spiritual activities concerned in the evolution of the mental phenome-

na. The reason, therefore, why our ideas are connected with one another very generally in accordance with the above relations is, that the organic acts upon which they depend have been again and again repeated, either voluntarily or through the influence of circumstances, in the order of those relations, until they at length have become chained together by habit, and the series when once started continues to move on, without the stimulus of outward impressions and without aid from the will. In the same manner, our perceptions acquired through the different senses, become linked to one another so that when any one class is awakened by the object to which they relate addressing that particular sense, the others are immediately introduced by the simultaneous action of the appropriate organs; and so close is the connection between the different classes of the associated group, that as we have already intimated, there is frequently much difficulty in separating them and determining which are the original and which the acquired perceptions. The great English dramatist appears to us, to have had a far more just conception of the true cause or principle of association among our ideas, than we usually find in the books of philosophy. The following passage from the opening scene in the Merchant of Venice, presents a fine illustration of the train of thought following the lines of connection, which interest and habit have established, and not the relations subsisting among the ideas themselves. Salarino is describing the anxiety and apprehensions which would prey upon his spirit, had he "such venture" at sea as Antonio.

My wind, cooling my broth,
 Would blow me to an ague, when I thought
 What harm a wind too great might do at sea.
 I should not see the sandy hour-glass run,
 But I should think of shallows and of flats;
 And see my wealthy Andrew dock'd in sand,
 Vailing her high-top lower than her ribs,
 To kiss her burial. Should I go to church,
 And see the holy edifice of stone,
 And not bethink me straight of dangerous rocks?
 Which touching but my gentle vessel's side,
 Would scatter all her spices on the stream;
 Enrobe the roaring waters with my silks;
 And, in a word, but even now worth this,
 And now worth nothing?

Why the continued repetition of a series of bodily or mental acts binds those acts together, so that the series once commenced flows on irrespective of any effort on our part, is a question which our present knowledge of the human constitution affords no means of an-

swering; and until more of the mysteries connected with this part of our nature shall be cleared up, we must be content to regard the truth as an ultimate fact. That some positive and permanent change is effected, both in the organization and in the spirit, there can be no doubt. But concerning its character, we would not venture even a conjecture. Nor would we dare to say that in the case of our bodily habits, the tie which connects the successive acts of which they consist, or more properly through which they are manifested, may not lie back in the spirit. This, it is well known, has other modes of acting upon the organization besides that of will. Of one of these, indeed, we have a striking example in the influence of emotion over the muscles of the countenance, and when particularly vivid, of the body generally, even when opposed by the most strenuous exertion of our voluntary powers. From recent anatomical and physiological investigations, there is reason to believe that this influence is exerted through an entirely distinct set of nerves, having a different origin and different properties from those which transmit the commands of the will—nerves especially appropriated to that office, and wholly incapable of ministering to either sensation or voluntary motion. Now it may be that in the repetition of those actions, which have been chained to one another by habit, so that the direct agency of the will is no longer required for their performance, an indirect influence is exerted through the mind voluntarily placing itself in special relation to the parts of the organization upon which the actions are immediately dependent, and retaining the meanwhile a certain latent consciousness of the general purpose to be accomplished by them. Indeed, something of this kind, we think every one is sensible of even when engaged in those occupations which custom has rendered most familiar to him.

Pursuing our investigation in the order which would seem to be indicated by the nature of the subject, we shall next consider the phenomena of conception. These do not, like those of sensation and perception, depend upon the action of any outward organs. Whether relating to the objects of sight, hearing, or smell, neither the eye, the ear, or the nose has any part in their production. Nay, their manifestation is clearest and steadiest when these organs have been put completely at rest, by the entire exclusion of the media which act upon them. Even the destruction of the organs, after they have once supplied the mind with ideas, does not impair the powers of conception.

But while there is abundant proof that this faculty is wholly independent of the outward parts of the bodily frame, there is equally strong evidence that in the present state, it cannot be exercised ex-

cept through the brain. In diseases of that organ the powers of conception are commonly disturbed sooner and also more seriously than those of sensation and perception. It is moreover well known that a moderate degree of pressure, applied to certain parts of the brain suspends, during its continuance, the exercise of all the mental faculties. And what is perhaps equally satisfactory on this point, in the ordinary and healthy condition of the organ, unusual or prolonged activity of any of the intellectual powers, occasions an increased tendency of the circulation towards it.

The question then arises, in what way and to what extent does the brain minister to conception? We answer, in the same way and to the same extent that it ministers to perception. The idea of an object we believe to be awakened by the spontaneous action of the cerebral extremities of the same nerves which, under the stimulus of impressions received through the senses, originally presented the object itself; the chief difference between the two cases being, that in the former, the action, though not originating in the will, is subject to its influence, while in the latter, it is wholly beyond the control of our voluntary powers. The reasons by which we are led to the adoption of this opinion, are,

1. The very close resemblance of our conceptions to our perceptions. This is seen not only by direct comparison of the two classes of phenomena, but from the fact that the former are continually mistaken by us for the latter. As we have already noticed, what are usually denominated acquired perceptions are only conceptions connected by the ties of association with the object which serves to introduce them. And yet so perfectly similar are they to the perceptions for which they pass, that it is only by the most careful attention, that we are able to distinguish them. In sleep too, when the senses are at rest and the power of the will over the cerebral organs is suspended, the ideas awakened by their spontaneous action, no longer under our control, assume the independent character of external existences, and while the state continues, are actually regarded by us as such. Indeed, it would seem, that whenever we lose the power of voluntarily shaping our conceptions and of banishing and recalling them at pleasure, whether it be through sleep, reverie, or insanity, we uniformly mistake them for perceptions, and our ideas, as they succeed one another in the mental train, appear to us as actual and outward realities. We are then in a state similar to that which the advocates of the wild scheme of idealism would have us believe to be our habitual and normal condition.—Now we say it is contrary to the analogy of every other part of the human structure and therefore *a priori* improbable, that in framing the special organism of the mind the Divine Being should

have constituted one extremely delicate and complex set of nerves for awakening our perceptions, and another equally delicate and complex apparatus for evolving our conceptions, when these two classes of phenomena are so nearly alike, that during our waking as well as our sleeping hours, and in health no less than under the influence of disease, we are continually confounding them with one another. It is far more in harmony with that beautiful simplicity, and that strict economy in regard to means which are so conspicuous in all the Creator's works, to suppose that both are produced by the same organs, and that the difference between them arises from these organs acting in the two cases, either in different ways, or what is perhaps more probable, with different degrees of intensity.

2. The association of our conceptions, through the corresponding perceptions. Whenever two objects have been repeatedly seen together, the idea of one in any manner awakened, immediately calls up that of the other. Whenever two sounds have been heard many times in connection with each other, the thought of one, however suggested, introduces that of the other. In like manner the recollection of a friend's countenance brings with it not only his general appearance, but the tones of his voice, the peculiarities of his manner, together with numerous circumstances connected with him, by virtue of associations established among these several ideas, through the perceptions which originally awakened them. Indeed it would seem that our conceptions are both more readily and more permanently linked to one another, by the simultaneous or successive repetition of the corresponding perceptions, than by a similar repetition of the conceptions themselves, owing, it is probable, to the organs evolving them acting with greater intensity in the former case than in the latter. Now all this is readily explained from the universal and all-pervading law of habit, if we suppose the two classes of phenomena to be dependent upon the same portions of the brain, but wholly inexplicable on any known principle of the human constitution, if we suppose them to be dependent upon different portions.

3. The apparent absence in the brain of any other organs besides those which minister, on the one hand to sensation and perception, and on the other, to automatic and voluntary motion. In order to have a just conception of this fact, and of its bearing upon the present inquiry, it will be necessary to consider somewhat more in detail than we have hitherto done, the structure and functions of the several parts of the nervous system—a circumstance which we are the less inclined to regret, as such a consideration will disclose new proofs of the wisdom and goodness of the Creator. It will moreover, show that even

in the most mysterious and inscrutable operations of life, there is no direct interposition of the divine agency, but that in this, as well as in every other department of nature, ends are brought about by means skilfully adapted to produce them.

Until within a comparatively late period, all the different nerves were supposed by physiologists to have the same office. They were believed to be the channels, through which impressions are transmitted from the outward organs to the brain, and from the brain to the outward organs. They were regarded as together constituting but a single system, which having its centre within the cranial cavity and radiating thence to every part of the body, regulates and controls all the living phenomena. From recent anatomical and physiological investigations, however, it is inferred, that instead of one, there are no less than five different systems of nerves, having as many separate and distinct centres and performing as many separate and distinct functions. These different systems are not isolated, it is true. On the contrary, they are connected with one another by numerous affiliations, whereby entire harmony of action is secured as well as the most perfect unity of result. Each system, however, is complete within itself, and may continue to act—a case which in certain diseases actually happens—after the others have ceased to perform their respective offices.

Two kinds of matter, and so far as can be ascertained from microscopic examination, only two, enter into the composition of each of these systems—the white and the gray. The white matter consists of a great number of exceedingly minute fibres, which together with the sheaths embracing and protecting them, make up the entire substance of the nerves. Its office is believed to be simply that of conduction, each tubulated fibre being in fact a separate channel along which impressions received at one of its extremities are transmitted to the other. Two distinct sets of nerves are connected with each system, the one afferent and the other efferent—the former serving to convey impressions from the circumference of the system to the centre, and the latter from the centre to the circumference.

The gray matter is very unlike the white. Its structure instead of being fibrous is glandular. It is moreover traversed by innumerable veins and arteries, which supply it abundantly with blood; while the white matter receives but a comparatively small quantity of this fluid. From these circumstances, as well as from the position which it occupies in the several systems, it is believed to perform the office of separating from the blood, the peculiar agent or fluid, whatever it may be, by which the transmission of impressions along the nerves is effected. It is collected into masses of varying dimensions, which either singly

or in groups, constitute the centres of the respective systems. All the afferent nerves terminate in them; all the efferent originate from them. Indeed it is only through these central masses of gray matter, that the two sets of nerves are connected with each other, and the circle of which they form parts, completed. Minute portions of the same substance are also found about the external extremities of the nerves of sensation, having for their office, it is thought, the secretion of the peculiar fluid or principle by which these nerves are excited to action. The mere mechanical impression made upon the outward senses is not, it would seem, their proper stimulus, but only the means of disengaging and applying it. It is not improbable that the extremities of all the other afferent nerves, are in like manner enveloped by the gray matter, although its existence about them has not as yet been demonstrated.

These observations are of a general character and apply equally to all the different systems of nerves belonging to the human frame. For the further elucidation of the subject, we add a few brief remarks upon the situation, structure, and offices of each.

1. Of the sympathetic system. This has no connection with either the brain or the spinal marrow, but is situated wholly without the cavity containing those organs. It was first separated by physiologists from the rest of the nerves, and received its name from the supposition that a peculiar sympathy is established through it, among the several parts which minister to nutrition and secretion. The concatenated masses of gray matter which form its centre, are lodged principally within the general cavity of the trunk, and the nerves proceeding from them are distributed mainly to the thoracic and abdominal viscera. Branches from this system also accompany the arteries throughout all their ramifications. Connected exclusively with the organs concerned in the maintenance of life, it is believed to preside over their action, and to regulate and harmonize their closely related and often mutually dependent functions. Hence it is frequently called the visceral system or the system of organic life. The nerves belonging to it are incapable of ministering to either sensation or voluntary motion, nor do they in any manner or at any point come into relation with the spirit. The connection between the latter and the parts to which they are distributed, is established solely through the medium of twigs and branches which come from other systems.

2. Of the excito-motary system. This has its origin in a series of ganglia occupying the axis of the spinal marrow, the exterior or fibrous portion of that body only serving to connect the sensory and voluntary nerves with the brain. Emerging at different points from this axial

line or rather chord of gray matter, and passing out through the surrounding layer of white substance, the efferent nerves go to all the muscles indeed, but more especially to those which are employed in respiration, deglutition, and other actions or motions equally necessary to the maintenance and perpetuation of life. The afferent nerves arising mainly, either from the external surface or from the internal membranes, and gathering themselves successively into twigs, branches, and trunks, make their way to different points of the spinal marrow, and having penetrated the outer layer of fibrous matter, terminate in the same line of ganglia from which the efferent take their rise. As in the preceding system, the nervous circles are thus completed without anywhere coming into relation with the spirit. Irritation of the afferent fibres immediately calls into action the efferent, neither sensation nor volition intervening. In this manner a large and important class of actions are provided for independently of any effort or knowledge on the part of the individual, so that they continue to be performed not only during the unconscious state of sleep but even after the entire paralysis of the nerves of both sense and will. Besides the mechanical acts of respiration and deglutition already alluded to, the moistening and lubrication of the eye by the frequent passage of the lid over it, the dilation or contraction of the pupil according to the degree of light, the spontaneous and spasmodic closure of the glottis against whatever, if admitted, would do harm to the lungs, the defence and control of all the entrances to the body, together with the habitual tone or tension of the muscles generally, depend upon this system. In many of the lower animals, it is much more largely developed and performs a greater number of offices than in man. These two systems, the sympathetic and the excito-motary, are the first which are called into action and the last which cease to act. Their functions commence with the organic life of the individual, and continue without interruption or cessation till that life is terminated. It is under the influence of the latter of these systems that the last dying struggles take place, after, it is believed, in many instances, all sensibility and consciousness have ceased—after, it may be, the spirit has already been loosed from its connection with the body.

3. Of the senso-motary system. This has its origin in a chain of ganglia situated at the base of the brain, and in intimate connection, on the one hand with the cerebrum, and on the other with the spinal marrow. The nerves of sensation, including those of the special senses, constitute the afferent branches and a corresponding set going to the different muscles—the efferent. This system is in immediate relation with the spirit. All our sensations are experienced through it,

and a large class of our actions are dependent upon it. It is not however alone capable of awakening perceptions, nor are its efferent branches directly acted upon by the will. Sensation and not volition is their proper stimulus. Hence the motions to which they give rise are spoken of as consensual. Of this character are the violent muscular contractions occasioned by the sudden application of heat and cold to the surface, the involuntary closing of the eye from excess of light, coughing, sneezing, vomiting, laughing, weeping, and numerous other similar acts which are performed not only without assistance from the will, but in direct opposition to it. Of the same character also are the various instinctive actions, which though comparatively few in the case of man, make up by far the greater part of the motions executed by the lower tribes of the animal kingdom. In all of these instances, the nervous circle is completed without the intervention of either perception or volition. There is no knowledge, no plan, no purpose. Some form of sensation or of emotion is the immediate and sole cause of the action.

4. Of the cerebral system. This is situated entirely within the cranial cavity, of which it occupies the larger portion. Its structure is far more compact than that of the preceding systems and the relative disposition of the two kinds of matter entering into it, very different. The gray, instead of occupying the centre, is situated at the circumference of the cerebrum, surrounding and enclosing the white on all sides, except where the latter, as already mentioned, forms connections with the ganglia of the senso-motary system. It consists in man of a layer, about the eighth of an inch in thickness, which follows the surface of the brain through all its irregularities, now passing over its eminences, and now descending into its depressions, so that if it were detached from the included mass, and all its numerous bendings unfolded, it would be of sufficient dimensions to contain a body eight or ten times as large. Indeed, it is not improbable that the chief object of these remarkable inequalities of surface is the extension of this peripheral layer of gray substance, and the consequent increase of its power as a secreting organ. More points are also thus presented for the reception of the innumerable fibres of the white or conducting matter, which radiating from the senso-motary ganglia, go to bury themselves in this layer. These fibres are closely packed, and together with the insulating material by which they are surrounded, and the veins and arteries which serve to nourish them, make up the whole interior portion of the brain. Their sole use, as it would seem, is to connect the ganglia at its base with the periphery of the organ.

Such is a general account of the structure of the cerebrum. Its

office as gathered from the teachings of comparative anatomy, from experiments made upon the lower vertebrated animals, and from various pathological phenomena observed in the case of man, is on the one hand, the awakening of ideas in the mind, and on the other, the transmission of volitions to the different members of the body. Impressions made upon the outward senses, are capable of exciting through the preceding system only sensations. Through this, they give rise to perceptions. The will has no power over the preceding system. By this its mandates are received, and conveyed to the muscles whose duty it is to execute them. Whether the fibres of this system, afferent and efferent, pass out through the senso-motory ganglia, and go to the several organs of sense and motion, or whether they terminate in those ganglia—the impressions made and received by them being transmitted through the preceding system—is not quite certain. Most physiologists incline to the latter opinion, although the analogy of the other parts of the nervous structure would seem to favor the former. Further anatomical investigations conducted by aid of the microscope are necessary for settling the question.

5. Of the cerebellum. This like the cerebrum is situated within the cranium, occupying the lower and back part of that cavity. Although of far inferior dimensions, the relative disposition of the two kinds of matter composing it, is the same,—the gray forming the peripheral, and the white the central portion of the organ. Its connections are with the cerebrum, the ganglia at the base of the brain and the spinal marrow,—more especially the two latter. From the study of its comparative development in the different orders of the lower vertebrated animals, as well as experiments made upon those animals, it is believed to be immediately concerned in the regulation and subordination of the different muscular contractions necessary to the execution of the more delicate and complex movements. Indeed there are scarcely any motions so simple as not to require for their production the simultaneous contraction of several muscles; and it not unfrequently happens, that the same muscle forms one, of two, three, or four different sets of muscles producing by their combined action as many different motions. Now the several muscles constituting each of these sets, are associated through the cerebellum, it is believed, in such a manner that their simultaneous and due contraction is determined by a single act of the will, directed by the idea of the object to be accomplished. When the cerebellum is removed from the brain of a bird, which it may be without materially affecting the vital functions, the bird, although retaining its powers of sensation, perception, and voluntary motion, is no longer able to execute with any precision

movements requiring the combined and harmonious action of several muscles. If on the other hand, the cerebrum be removed, it retains the power of sensation and continues to perform a great variety of instinctive and consensual motions, but it no longer shows signs of either perception or will. If food be placed in the mouth, it is swallowed, and life may in this way be sustained for weeks or even months. But no intelligent, voluntary effort is made by it for procuring the means of sustenance.

From the brief view which we have thus presented of the different nervous centres and of the functions respectively connected with them, it will be seen that our present inquiry has to do more especially with the cerebrum. This is the seat of perception and of volition. Through the instrumentality of this, ideas are awakened, which supply material to the intellect, and furnish, as it were the basis of all its operations. When quickened into action in any part by impressions conveyed to it from without, through the medium of the sensory ganglia, the ideas to which it gives rise are recognized as perceptions. When, on the contrary, the action originates within, whether spontaneously through the power of habit, or from the influence of the will, the ideas evolved are recognized by us as conceptions. In both cases, however, the same parts of the cerebral structure are concerned in their production. Each of the senses has its own separate ganglion, in which the nerves ministering to it all terminate. There is one for seeing, another for hearing, a third for smelling, a fourth for feeling, and perhaps a fifth for tasting, although it is not quite certain whether this sense is anything more than a modified form of touch. These ganglia, as already stated, are intimately connected with the cerebrum, by dense bundles of fibres which radiate from them to its circumference, and which are supposed to be the immediate instrument in awakening our varied perceptions. Now what we would have especially observed is, that only one of these ganglia—we mean on the same side, for the brain like the external parts of the organization is throughout double—is found to each of the senses. There is not one ganglion for awakening the *perceptions* of sight and another similar and associated ganglion for awakening the corresponding *conceptions*. The same is true of hearing and smell and touch. In the case of no one of them, is there but a single interior organ, which can be supposed to have any part in developing the ideas, whether perceptions or conceptions belonging to it. Remove from the brain the sensory ganglia, together with the entire mass of fibres which go from them to the gray matter of the cerebrum, and there would remain only the parts subsidiary to motion. From the structure therefore of the great nervous centre with which the mani-

festation of the mental^s powers is immediately connected, as well as from the close resemblance of our conceptions to our perceptions and the readiness with which associations are established among the former, through the latter, we conclude that both classes of phenomena are dependent upon the same parts of the brain; and that as we have already said, these parts are excited to action in the one case by outward causes, over which we have no voluntary power, and in the other by influences within, to a greater or less extent under the control of the will. In both cases, the organs are the same, and the kind of action is the same. The only difference is in its origin and degree.

In pursuance of our purpose of tracing the organic dependence of the several classes of mental phenomena, we shall next consider *recollection*. This is more complex than any of the acts or states of the spirit, to which we have thus far directed our inquiries. It involves conception and something in addition to it. In its simplest form, it consists of the reproduction and recognition of a former idea. The first of these is a mere act of conception, which is accomplished as in any other case, through the instrumentality of certain parts of the brain. In its ordinary, spontaneous form, it is the result of some association which has been established between that, and the act or state immediately preceding it in the order of the mental train. The second is a purely spiritual cognition, wholly independent of the material organization, except so far as that is necessary for evolving the ideas to which it relates. It is an intuitive judgment which the mind forms on comparing what it is at present thinking or perceiving, with what it has previously thought or perceived, including, it may be, along with the main idea, more or less of the attendant circumstances—a judgment by which the two things are affirmed to be identical. As this judgment which the mind thus passes, has exclusive reference to its own consciousnesses awakened indeed by the action of the cerebrum, but not themselves organic, it is obvious, that it must be a simple act of the spirit, and would therefore continue the same, were the brain entirely dissolved, provided the same mental states should be produced through the medium of any other agent or organ.

Besides the cognitions of memory, there are numerous other intuitions of the spirit, which are equally independent of the cerebral organism, and which would in like manner continue to arise, in whatever way the ideas forming their subject should be presented. In truth the entire class of interior perceptions, which by transcendental philosophers are referred to the pure reason, would seem to be of this character; and if we mistake not, it is by this character, and this alone, that they are distinguished from the so-called phenomena of the

understanding. The latter are immediately produced by the action of the material organs upon the spirit, and under our present constitution and present circumstances, are capable of being produced in this way only. Were our constitution changed or were the media by which we are surrounded altered, then the same phenomena might be exhibited under other and different conditions; but in our present state, their manifestation is inseparably connected with the body. The former, on the contrary, are not the immediate or necessary result of the action of the brain, but arise in the mind by virtue of its own inherent endowments, when the ideas awakened by that action are contemplated. Such are the axioms of arithmetic and geometry. Such are the first principles in morals and metaphysics. These truths are directly apprehended, while the conceptions to which they relate are awakened through the organization. This secondary character which belongs to the entire class of intuitive or rational perceptions, and by which they are removed from all bodily connections, and carried back wholly into the spirit, appears to be what with the philosophers above referred to, has led to the conclusion however unjustifiable, that they spring from a source beyond and above the individual in whom they are manifested.

Of the same secondary character are the various desires, sentiments, and feelings of which we are susceptible. They are not the immediate result of the action of the brain upon the spirit, but spring up in the mind from the contemplation of ideas of a nature fitted to produce them. The ideas are awakened by the action of the brain, but the desires and feelings by the ideas. The modern phrenological doctrines which refer the intellectual and moral sentiments to certain parts of the cerebrum as the immediate instruments of their manifestation, are no less at variance with the true exposition of the mental phenomena as revealed in consciousness, than they are inconsistent with all just views in regard to the structure and functions of that organ; and we venture further to express the belief that could all the sources of error necessarily attendant upon their application to the determining of character be excluded, their failure to bear this last practical test of their soundness would be found equally signal.

We have thus far considered only the elementary powers of the mind. Its more complex operations and processes however, such as analysis, synthesis, ratiocination, and generalization will require but a brief notice in connection with our subject. Indeed, they will be found upon examination to be made up of the simple acts and states which have already passed under review. They all necessarily involve conception. This runs through them and constitutes the chief

and essential ingredient in their composition. Without this, they would be impossible. In fact, each one of the processes consists in the development of conceptions under the guidance of either the intuitions or the sentiments. Analysis is the separate and independent production of ideas which having entered the mind simultaneously, ordinarily present themselves in a combined, or more strictly speaking, associated state. Synthesis is the simultaneous production of ideas which having entered the mind at different times and under different circumstances, ordinarily present themselves in a disconnected state. When the ideas thus brought together are associated according to their philosophical relations, it is said to be an exercise of the understanding or the reason; and when in accordance with their poetical relations, of the imagination or the fancy. In the same way, ratiocination is the spontaneous or voluntary development of a train of ideas in the order of their logical connections, accompanied at each step by the perception of these connections; and so of the other mental operations. They all consist in the production of ideas connected with one another by certain definite relations, the intuitive apprehension of which furnishes the guide to their development. They are therefore dependent upon the action of the cerebrum, inasmuch as this is necessary to the awakening of conceptions. But they also involve the exercise of other and higher powers which are wholly independent of the cerebrum—which belong exclusively to the spirit, and which would continue the same although its connection with the body should be dissolved. Such are the various intuitions which enter essentially into these processes, and in fact determine their character. They together make up the human intelligence, and are of a nature so superior to the mere outward perceptions, dependent upon the organization, that as we have already said, they have been supposed to have their origin in the Divine mind. Indeed, the former class of powers are almost as highly developed in many of the lower animals as in man. It is the want of the latter that chiefly constitutes their inferiority, and must forever restrict them to the humble place they occupy in the scale of created intelligences.

Before dismissing our subject, it may be proper briefly to advert to one or two consequences which would seem to follow from the foregoing exposition of the mental phenomena, and which by many may be regarded as an insuperable objection to the views presented. If the mind be awakened to action only by the presence of ideas, and if these are evolved under our present constitution through the instrumentality of the brain, then it follows, it may be said, that the spirit on its separation from the body must pass into a state of profound and unconscious repose. Having now neither perceptions nor concep-

tions, there will be nothing to awaken its sensibilities or call forth its powers. That such a conclusion follows legitimately from the premises, provided we suppose the spirit on laying aside its connection with the body, not to assume any new connections or enter into any new relations, we think must be admitted. Indeed the same thing might be inferred from the loss of consciousness which takes place whenever the action of the brain is temporarily suspended, as in paralysis or syncope. During the continuance of these, so far as we can judge from appearances and from the subsequent recollections of the individual, there is a total cessation of all thought and feeling. The mind is apparently in a state of unconsciousness, as profound as that from which it was awakened by the first impressions made upon it through the organization.

But if the spirit be destined to survive the body, all analogy would lead us to expect that other instrumentalities will be provided, for enabling it to carry on its own processes, as well as for putting it in communication with surrounding existences. It is not necessary that these instrumentalities should be like those at present made use of, organic. In its new state of being, the spirit for aught we know, may be bathed on every side by a subtle essence or medium, which shall disclose to it surrounding existences, in the same manner as light reveals their external forms to the eye. Whoever will compare our capacity for knowledge with our present means of acquiring it, cannot fail to be struck with the great disparity between them. A child may learn in a single day what it has taken a whole life-time to discover. The information imparted by the senses is extremely limited. They at best make known only the outward phenomena. Of the essence and properties they tell us nothing. These must be sought by long and laborious processes of experiment and induction; and even after we suppose ourselves to have arrived at them, as the method pursued was not direct but merely inferential, further investigation may show that we were in error. Were a new sense to be granted to us, by which we might look into the interior of bodies and see their component atoms, might observe the different ways in which those atoms act upon one another, and how that action gives rise to the innumerable changes which are everywhere occurring, with such a faculty a single glance around us would give a deeper insight into the real nature and actual constitution of things, than has been gained by the combined researches of philosophers during a period of six thousand years.

Nor is the mode in which the spirit holds intercourse with other spirits in the present state, at all so simple or perfect as might be conceived. Instead of direct communion with them, or the rapid inter-

change of thought and feeling, through the medium of some intervening agent, recourse must be had to a complicated system of means, involving numerous actions and reactions, for conveying the simplest idea. In the first place, the idea must be expressed. In order to this, couriers are despatched along the nerves leading to the vocal organs, and these are called into action in such a manner as to form the particular sounds which represent it. These sounds breaking upon the surrounding air, are borne upon its waves to the ear of the person addressed, which entering they traverse its successive compartments—undergoing in each certain important modifications—until they at length reach its termination in the auditory nerve. Here an entire change takes place in the character of the action. From a mere mechanical impulse or vibration, it is converted into an agency or influence of a far more subtle nature, which is transmitted along this nerve and which on arriving at its interior extremity, where it is in relation with the spirit, appears in the form of a sensation. Finally, by virtue of an association established between them, this sensation introduces the idea which it was the object of the entire process to communicate. That such a mode of intercourse, however well adapted to our present condition as physical and organic beings, will be retained by the spirit after it has laid aside its material connections, no one can for a moment imagine. What other more direct and simple mode will be substituted for this, it is impossible to say; although the wide diffusion of certain ethereal media and the important ends which they subserve in the general economy of nature, would suggest the probability that these may in some way be subsidiary to that more perfect communion which we suppose spirit to hold with spirit.

It may be further said, by way of objection to the foregoing views, that if, as supposed, the ideas of memory are awakened through the organization, on the dissolution of that, the faculty itself must be destroyed and the whole previous existence of the individual become thenceforward an entire blank. That such is not a necessary consequence of what has been said, will be obvious we think, on a moment's reflection. In whatever manner our former ideas may be reproduced, whether by the instrumentalities at present employed for that purpose, or by others equally adapted to the same end, as long as the power of recognizing them continues—a power which resides in the spirit itself, and is wholly independent of the organization—so long the faculty of memory must remain. Indeed, should our means of recalling the past in another state be more perfect than they are at present—which is at least supposable—then this faculty may not only continue unimpaired, but be greatly improved, so that it shall disclose to us in

the retrospect of existence vistas, of which we have now no conception.

From the rapid view which we have thus taken of the several classes of the mental phenomena, it appears that there is no evidence of their being dependent upon the organization, in any such manner as to render that necessary to their development. Nor is there in any of them, evidence of an actual dependence under our present constitution, at all different in kind from that which is manifested in the simplest cases of ordinary perception. The ideas originally awakened through impressions made upon the senses are subsequently reproduced by the spontaneous action of the interior or cerebral portions of the same organs. The intuitions of the reason, as in their first appearance, so in their subsequent manifestations, are wholly independent of the brain. They arise in the mind by virtue of its own endowments, whenever the ideas to which they relate are presented to it. There is nothing therefore, in the connection between the spirit and the body, so far as we are able to trace it, to afford ground for the belief, that the dissolution of the latter will be attended with the destruction of the former, or even with a diminution of its powers; but on the contrary, it is entirely supposable, and the law of progress so visibly inscribed, not only on our own nature, but upon every part of the Creator's works, would lead us to expect, that these powers will be greatly enlarged, by its introduction to new and higher relations fitted to call forth energies which are now dormant.

ARTICLE VIII.

BIBLICAL CHRONOLOGY.

WE have translated and we herewith present to our readers the Chronological Tables on Biblical History, inserted by Winer as an Appendix to the third edition of his *Biblisches Realwörterbuch*, Leipzig, 1848. It is a convenient summary of the results of the latest investigations of archaeologists and commentators in relation to this subject. Many points, it is well known, are in dispute. Some of them never can be settled, for want of adequate data. It may be well, however, to present the conclusions, (in some instances conjectures,) of a scholar so industrious and able as Winer. The mark * indicates the death of the person with whose name it is connected.—E.