Address.

SOME FACTS AND FANCIES ABOUT MIND AND BODY.*

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MR. PRESIDENT AND FELLOWS OF THE MASSACHUSETTS MEDICAL SOCIETY: "Electricity is not a form of energy, any more than water is a form of energy. Water may be a vehicle of energy when at a high level or in motion; so may electricity. Electricity cannot be manufactured, as heat can; it can only be moved from place to place, like water; and its energy must be in the form of motion or of strain. Electricity under strain constitutes 'charge'; electricity in locomotion constitutes a current and magnetism; electricity in vibration constitutes light. What electricity itself is we do not know, but it may, perhaps, be a form or aspect of matter. So have taught for thirty years the disciples of Clerk-Maxwell. Now we may go one step further and say matter is composed of electricity and nothing else."

The quotation I have read you from the pen of Sir Oliver Lodge, as it appeared in *Harper's Magazine* for August, 1904, must serve me as introduction and text, from which I reserve the right to wander wide, as do some theologians. I would refer you for a complete elucidation of the "Electronic Theory of Matter,"—which I shall only touch in its relation to my theme,— to Sir Oliver Lodge's unabridged thesis, in the *Scientific American Supplements*, Nos. 1428 to 1434, inclusive, and to "Modern Theory of Physical Phenomena," by Augustus Rigbi, as translated by Augustus Trowbridge, and published by the Macmillan Company in 1904.

As my subject deals largely with theories, I may quote you in partial justification that "theory originally fashions science out of facts, and is the indispensable precondition of every important scientific advancement."

Without further introduction or attempt to disarm you, I submit my story.

Some years ago a personal friend, a physician of the best type, and one of the senior members of this Society, talked to me of some daydreams of his early manhood. At a certain age he supposed there must be men living wise enough to explain all the mysteries of life and mind. The phenomena of mind seemed included in those of life, but conscious life, or self-consciousness, seemed an additional problem, and a superadded mystery. He could not then see how these problems could be solved by the laws of molecular physics; and after many years of study, with mind keenly alert and open to the evidence from chemical and physiological laboratories, the mystery to him continues supremely interesting, but as much a mystery as in the days of his early boyhood.

As a boy, he looked for some great preacher or philosopher to explain these mysteries. As he left his rural home, the village preacher and the academy teachers to sit at the feet of college professors, his expectation was keen and his faith ascendant. His acute interest in the problems of nature drew him to physiology and chemistry, while a natural bent and sympathy for humanity led him into the ranks of medicine. In the pride of his knowledge as a college senior there lurked a sense of disappointment, not because he had slighted opportunities, rather because of a dawning suspicion that behind the veil of phenomena were laws and realities the ultimate nature of which he might never know. As he began his medical studies, smoldering expectation was fanned to a glow, hope rose high again; gross anatomy and the physiology of organs were interesting, but in microscopic anatomy and cell biology, especially as applied to those cells of the central nervous system, lay hidden the veritable elements of the soul. If the riddles of life were not solved, it was held to be due to imperfections of the microscope or to faulty technique; but this was more than forty years ago. The science of physiological psychology was then young and overconfident. It pointed with pride to the revelations of its inductive and experimental methods, and, in the assurance of its lusty youth, laughed its older rival, metaphysical psychology, to scorn. Maudsley's thesis on "Body and Mind" had not then been written, but Herbert Spencer's "First Principles" was being widely read, and Charles Darwin's "Origin of Species" had been published several years. The influence of this masterpiece of a master mind was even then shaking the foundations of many cherished beliefs concerning things of earth and heaven. Doubt and apprehension were the first reactions for many conservative minds. Gleesome aggressiveness marked the attitude of others who thought they saw in the theory of evolution the beginning of the end of man's faith and hope in the soul's immortality. "The brain secretes thought and consciousness as the liver secretes bile," and "Without phosphorus no thought," were pithy epigrams which served as a rallying cry in the rebellion of the nineteenth century against the older philosophy in favor of a strictly material interpretation of the phenomena of conscious mental life.

It would not be quite true to say that these catch phrases have no potency to-day, but the fallacies they embody have been many times uncovered.

"With phosphorus you light your candle, and with phosphorus you discover Neptune and write the Fifth Symphony; how charmingly simple and convincing," wrote John Fiske[1], with thinly veiled irony. "And yet was anything save a bit of rhetoric really gained by singling out phosphorus among the chemical constituents of brain tissue rather than nitrogen or carbon?" "The phosphorus philosophers have often compared thought to a secretion," writes William James.[2] "'The brain secretes thought as the kidneys secrete urine or the liver secretes bile,'"

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are phrases one sometimes hears. The lame analogy need hardly be pointed out. The materials which the brain pours into the blood (cholesterin, creatin, zanthin, or whatever they may be) are the analogues of the bile and urine, being in fact real material excreta. But we know nothing connected with kidney and liver activity which can be in the remotest degree compared with the stream of thought which accompanies the brain's material secretions."

These opinions from the writings of two of the New World's profoundest scholars were written in the dawn of the twentieth century.

In a recent paper on the treatment of paresis, Dr. Edward Cowles[3] writes: "We are learning that inasmuch as psychology can tell us nothing to explain the normal mechanism of mental activities, we cannot expect to see through the microscope an explanation of diseased thoughts and feelings."

We must not conclude from this that Dr. Cowles was unmindful of the alleged way in which, according to the laws of cerebral association, neural undulations transform themselves into sensations, sensations add themselves together to form feelings, and feelings unite themselves to form ideas, and ideas congregate to form abstract reasoning, etc.; rather we understand the doctor's meaning to be that physiological psychology and anatomical pathology do not adequately explain. His hope apparently turns to the deeper underlying plane of physiological chemistry, and he quotes Dr. Otto Folin approvingly as follows: "Microscopically visible structural changes in any tissue or in the cells of any tissue must be preceded by more or less pronounced metabolic changes. Metabolic changes are chemical changes. Chemical changes are the physical exchanges and transmutations that take place in the physical units of matter, the molecules; and the molecules are beyond the ken of the microscopists."

These quotations of a comparatively recent date, from men well informed in that medical specialty most concerned with the phenomena of mind, neither affirm nor deny the material nature of our conscious mental life. They do point to a growing recognition of the limitations of science to unravel mysteries which seem to defy the microscope and, it may be, chemical reagents. They do mark by sharp contrast the modest claims of the older science of to-day from the cock-sure attitude of the youthful science of forty years ago.

It seems — if we may paraphrase a famous saying of Bacon — that a superficial knowledge inclines men's minds to make a fetich of science, while a deeper knowledge reveals the limitations and points to the truth that science deals with the causal relation of phenomena, and that physical science takes account only of physical phenomena and their related sequences and is utterly incompetent to pass judgment about things non-material or beyond the limits of man's experience in the body. I have so presumed on the instinctive interest in humanity and its destiny, underneath the scientific finish of members of this Society, as to ask your attention to two modern theories which seem most worthy concerning the relation of the minds and bodies of of men.

First, I would call attention to some features of the brain productive or "liver-bile" function theory of the ultramaterial psychologists, and, secondly, to some phases of the transmissive brain function theory of Schiller[4] and William James.[5]

I do not know that the liver-bile, brain-thought theory is more commonly held by members of our profession, yet the conclusion easily follows the observation of the coincident development of brain and mind, the lapse of consciousness from pressure on or injury to brain tissue, and the greater intelligence of men and animals having the deepest cerebral sulci and the most complex arrangement of cortical gray matter. I doubt if the case of the physiologist has been more strongly put than in the words of Sir Frederick Harrison,[6] who wrote, in defending the so-called "positive philosophy," more than thirty years ago: "Man is one, however compound. Fire his conscience and he blushes. Check his circulation and he thinks wildly or thinks not at all. Impair his secretions and his moral sense is dulled, discolored, or depraved; his aspirations flag, his hope, love, faith reel. Impair them still more and he becomes a brute. A few drinks degrade his moral nature to that of a swine. Again, a violent emotion of pity or horror makes him vomit. A lancet will restore him from delirium to clear thought. Excess of thought will waste his sinews. Excess of muscular exercise will deaden thought. An emotion will double the strength of his muscles. And, at last, the prick of a needle or a grain of mineral will in an instant lay to rest forever his body and its unity, and all the spontaneous activities of intelligence, feeling and action with which that compound organism was charged."

With a mind tuned to recognize the significance and interdependence of that aggregate of phenomena we call mind and that aggregate of phenomena we call body, we turn eagerly to chemistry, physics and physiology for the justification of our expectations.

This domain of molecular physics populated by hypothetical molecules, divided into hypothetical atoms and subdivided into hypothetical electrons, might well put to shame the fairy dreamland of imaginative childhood.

Chemistry tells us that matter is indestructible. The proof is so conclusive that no scientist has a doubt. As one form of matter is transformed into another, perchance a solid into a liquid or into invisible gases by disturbing molecular relations, so it seems established that the many so-called forces are transmutable one into another. Force being manifested only in motion of matter it would be easy to conclude that no force existed where there was no visible motion. But molecular motion, like some forms of matter, may not be visible and the correlation and equivalence

of forces or "the conservation of energy," so-called, represents a doctrine seemingly as impregnable as the axiom of the indestructibility of matter. In searching for a material explanation of the phenomena of life and consciousness we naturally inquire concerning the physical and chemical properties of living matter and matter that has never lived. Again we are told that, so far as the chemist and physicist have knowledge, the distinction is not fundamental, for inorganic bodies and living organisms have very similar chemical elements.

Verworn [7] declares that "the life process consists in the metabolism of proteids," yet carbon, hydrogen, nitrogen, sulphur and oxygen, — elements so conspicuous in inorganic nature, — make up the complex proteid molecule.

While it seems to be established, therefore, that "the vital phenomena of organisms should follow the same general chemical laws as the phenomena of the inorganic world," we should not miss the significance of that supremely important fact that proteids "are never wanting in living substances and are never found in the inorganic world." [8] Hence it is that in the complexity of that proteid molecule seems to lie hidden a key to the mystery of life. And yet, that molecule is not uniform, we are told by competent chemists. While its elements are but five or six, its atoms vary in position and often number far beyond a thousand,[9] — and the key is not readily found. According to Pflüger,[10] "living proteid does not need to have a constant molecular weight; it is a huge molecule undergoing constant, never-ending formation and constant decomposition, and probably behaves toward the usual chemical molecules as the sun behaves toward small meteors."

Then we would further inquire as to the difference, if there be a chemical difference, between the living and the dead proteid molecule. Here, we are told, there is a fundamental difference, as evidenced by a comparison of the decomposition products of living proteid and those obtained by the artificial oxidation of dead proteid. While the non-nitrogenous, or hydro-carbon, decomposition products of the two are essentially the same, the difference in the nitrogenous products of living and dead proteid is marked and important.

It seems, if we may trust Pflüger and Verworn,[11] that in the decomposition products of living proteid may be found that exceedingly poisonous gas cyanogen, which unites with hydrogen to form the deadly hydrocyanic acid and with oxygen and metallic bases to form the highly explosive fulminates. Cyanogen, it seems, is formed by the union of a single atom each of carbon and nitrogen. It acts as a radical in chemical compositions, and is noted among chemists for the intensity of its internal energy.

All chemists may not agree with Verworn and Pflüger [12] that living proteid is distinguished from dead proteid most of all by the vivifying presence of that fiercely energetic radical cyanogen; yet if it be established beyond peradventure, it is a curious fact that a radical so closely related to the deadly prussic acid and the explosive fulminates should be the essential chemical representative of life.

If we agree with that axiom of physics that every manifestation of force is a mode of motion, molecular or molar, and consent to that other dictum of science that each mode of motion persists until transformed into some other mode of motion, then we are ready to inquire what becomes of the neural currents passing almost continuously from periphery to center through nerves of special sense. If you hold that these currents are dancing molecules of matter, each unit imparting its motion to the molecule next nearer the center, as physicists have taught, or agree that the phenomena is better explained by the conception of free electrons chasing one another from molecule to molecule of nerve tissue, — as physicists may teach, — then, it is pertinent to inquire, Is this motion transformed into feeling and thought, or is it transmitted along centrifugal neural transit lines to appear in molar motion, as in the voluntary movement of an arm, or in altered or augmented secretion or other forms of molecular motion? Or, may it be that part of the afferent motion is absorbed in feeling and thought and part directly transmitted along afferent neural lines?

We are told that the last hypothesis was indorsed by Herbert Spencer in the first edition of his "First Principles," but later in life his views changed, and attention was called to the change in the preface of the last edition of that work; his later conclusion being that thought and feeling were outside the neural transit circuit and could not be equivalent to, although concomitant with, the molecular motion of matter. He had come to believe with du Bois-Raymond [13] that, "if we possessed the same knowledge of atoms that we have of the motions of the heavenly bodies we would understand all the phenomena of the physical world, but we would not understand how consciousness arises, nor how the simplest psychical phenomenon comes to be." "It would be," as du Bois-Raymond expresses it, "of unbounded interest, if, with our mental eye turned inward, we could observe the cerebral mechanics of an arithmetical problem; or if we could know what dance of the atoms of carbon, hydrogen, nitrogen, oxygen and phosphorus corresponds to the delight of musical sensation, what whirl of such atoms to the acme of sense enjoyment, and what molecular storm to the frantic pain from maltreatment of the nervus trigeminus." "But however carefully we might follow the motions of individual atoms in the brain we could see only motion, collisions and again motion."

And so it is that we are returned by material paths to seemingly soundless depths where lie hidden the mysteries of energy and consciousness.

According to Mr. Percival Lowell,[14] "the neural current of molecular change passing up the nerves and through the ganglia reaches at last the cortical cells, there to find a set of molecules

less accustomed to this special change. The current encounters resistance, and in overcoming this resistance it causes the cells to glow. The white heating of the cells we call consciousness. Consciousness, in short, is probably nerve glow." This, of course, is the mechanical point of view delightfully simple and easily grasped. But admitting that the cortical cells do glow, what and where is the percipient? Do the cortical cells cognize their own glowing? The molecules of a wire glow literally if the wire is not sufficiently large for the free passage of an electric current; yet one would hardly suppose the wire to be conscious because the vibrations of its molecules are timed to produce the kind of ether waves we recognize as light.

The terms "cerebricity" and "neuricity," which have crept into our medical literature, descriptive of the energy supposed to be stored in the cortical cells of the cerebrum and minor nervous ganglia, were born out of wedlock most likely, but they stand for a new idea, and the minds of men run after new ideas in science, as in theology, "even as sparks fly upward."

It seems as if the tendency has been towards reducing all the material sciences to problems in molecular physics and of late certain electrophysicists are claiming the earth with all creatures of the land and sea,— and not these alone,— "the golden sun, the planets, all the infinite hosts of heaven," if we may use the poet's phrase, are counted subjects and creatures of electricity.

In passing to a consideration of the transmissive brain-function theory, it is embarrassing to remember the contempt which the so-called "deterministic" psychologists and some who are wedded to the liver-bile, brain-thought idea, hold for any hypothesis which admits the possibility of a non-material intelligent reality that may exist apart from a nervous organization. In the face of such problems, however, as the essence of matter and energy and the origin of life, sensation and consciousness, pride of opinion seems hardly worth while.

Some of us have failed to understand how a nerve cell or a nerve fiber can think, hope, fear, love or aspire, in spite of all we have been taught of the brain's wonderful mechanism, and it is quite as difficult to understand how many nerve cells and nerve fibers acting in unison and helping one another can produce a sensation, even, unless we assume some sort of a percipient that can interpret the molecular vibrations and atomic motions which seem to constitute the physical part of feeling and thought.

It is somewhat comforting to learn that men of such scientific attainments as Virchow, Helmholtz, du Bois-Raymond, William James and John Fiske, in the full maturity of their magnificent intellects, have, likewise, been unable to understand, from such an hypothesis, how feeling and thought come to be. It does seem to be true, as Schiller [15] and James [16] have pointed out, that we have quite as good reason for thinking of the function of the brain as a transmissive function as to think of it as producing thought and consciousness as the liver produces bile. As the keys of an organ open successively the pipes and let the wind in the air chest escape in various ways; or as the prism transmits, bends, distorts, or separates into the colors of the spectrum the white light of nature, so the brain is conceived to transmit in part, bend, distort, and separate, according to its integrity and plane of development, the infinite intelligence of an Eternal Omniscience. As Professor Schiller puts it, "Matter is an admirably calculated machinery for regulating, limiting and restraining the consciousness which it encases. If the material encasement be heavy and simple, as in the lower organisms, it permits only a little intelligence to permeate through it. . . . If a man loses consciousness as soon as the brain is injured, it is clearly as good an explanation to say the injury to the brain destroyed the mechanism by which the manifestation of consciousness was made possible, as to say it destroyed the seat of consciousness."

The brain-productive function and the brain-transmissive-function theories both agree that the phenomena of mind are conditioned by the action of some kind of energy upon cells of living nervous matter; but whether this energy is a minute part of that universal energy which keeps the planets and stars true to their courses, or a special kind of "vital force" belonging alone to living organisms, science does not yet permit us to say.

The production theory assumes that the relationship of conscious intelligence to the brain may be likened to music and the harp. When the harp is broken there can be no music forevermore. The transmission theory may also liken the brain to the harp, and those outward phenomena of mind of which voice, gesture and smile are parts, to those vibrations of ether we recognize as pleasing harmony or unpleasant discord. But the transmission theory takes further notice of the harper, without whom there can be no music, and the harper is likened to the mind or conscious intelligence, whose instrument is the whole human organism, more especially the brain.

We do not suppose such reflections come within the domain of science; certainly not within the scope of any but of the concrete sciences. If every proposition be entirely true, science could not demonstrate the truth, because the conditions are outside the sphere of man's physical experience, and "science is but the codification of experience and is helpless without the data which experience furnishes." [17]

Must we then apologize for asking your attention at this hour to groups of ideas not strictly relevant to the problems of any concrete physical science? Man seems to be the only animal capable of abstract reasoning, and it may be that the "Absolute Mind" intended man should use his peculiar talent for the gratification of an instinctive interest in his own destiny in time, and after time, for him, has ceased to be.

We have purposely avoided introducing such evidence of the existence of a non-material in-

telligence as the reports of the societies for psychical research offer in abundance, and have refrained from quoting from such writings as Hudson's "Laws of Psychic Phenomena" and "The Scientific Demonstration of a Future Life," although we have no reason to suppose the investigations of the "psychical researchers" were not carried through in a scientific spirit. We would consent to Hudson's proposition that "a mental state is as much a fact as a mountain," but the field is too broad and the details too lengthy to be of service now. If any fellow would examine this line of evidence, we would refer him to Frederick Myer's "Human Personality," published by Longmans, Green & Co. of New York.

Some members of this Society were studying psychology in a practical way before the reader had learned even the names of the cranial nerves. At the bedside of suffering mothers you have helped into the world tiny beings with no self-consciousness and for whom world-consciousness was yet but dawning. The manifestations of love and aversion, hope and fear, joy and sorrow, anticipations, aspirations and alternating states of consciousness and unconsciousness are very familiar phenomena to you. If you have not measured, in time, different cerebral reactions nor constructed theorems, or classified, as have the professional psychologists, yet, more directly, you may have reached conclusions as substantial as theirs.

Attraction plus repulsion of material molecules may solve the riddle of life to your satisfaction. You may believe that thought and feeling are as much modes of motion as are heat, light or electricity. You may hold that "to know and to feel and to will" are but varying kinds or degrees of excitement of a nervous organism — nothing more and nothing less. If you are forced from this position by the demonstrations of science that every unit of afferent energy and every bit of centripetal motion can be accounted for by an equivalent quantity of other forms of efferent motion, molecular or sensible, without including conscious intelligence in the circuit at all — then you may fall back with Ernst Hæckel to the obscure if less vulnerable position, that the germs of mind are and have been inherent attributes of matter from before the time when this earth — a gaseous cloud of nebulous matter — was a new-born child of the sun.

On the other hand, giving due weight to the unvarying concomitance, within the limits of our experience, of the phenomena of mind with neural undulations and molecular activity of the body, you may yet hold that the relation, so far as science can reveal, is but a concomitance or induction of material motion by an unknown energy.

If we allow our minds a wide range and notice with F. C. Schiller, William James and John Fiske, all the testimony the concrete sciences have to offer, which our intelligence will accept as pertinent, then I venture the opinion that many of us will be forced to conclude that the transmission of the relation of psychic phenomena to the brain is the theory most consistent with all the facts and most worthy the credence of scientific men.

But whatever conclusions we reach, the imperfections of science limit us to a conclusion based on moral probability. We assume that members of this Society are not yet ready to accept the credentials of a moral and mental science. "Nevertheless," in the language of Sir Oliver Lodge,[18] "many of us are impressed with the conviction that everything in the universe may become intelligible if we go the right way to work." And so it is that every new discovery or theory in molecular physics, or in any science that may be reduced to electro-physics, may appeal, not alone to our professional interests, but to the very instincts that are the heritage of our common humanity.

For many years men of science have accepted the hypothesis of an immaterial cosmic ether pervading all interstellar as well as all intermolecular space. Science has insisted on the right to this assumption, in order to frame a partial explanation of such a common phenomenon as light.

For many years the unscientific world has accepted the hypothesis of an immaterial entity called spirit or soul. Ordinary sense has insisted on the right to this assumption in order to explain certain phenomena common to conscious mental life.

Some men have doubted the existence of an imponderable entity like cosmic ether which cannot be seen, heard, felt, tasted, or detected by the reagents of the chemist, yet these doubters have offered no explanation of common physical phenomena, independent of this hypothesis, that would be accepted by science or common sense.

Forty years ago it was an easy thing for newly fledged scientists to explain the phenomena of conscious intelligence to their own satisfaction, without the hypothesis of soul or spirit. To-day it is safe to say a majority of those well versed in science will agree with Sir Oliver Lodge that "Testimony is borne to inner personal experience on which physical science does well to be silent." But physical science has made wonderful strides in the past decade, and we must admit that molecular and electro-physics have carried off most of the honors. Roentgen's epoch-making discovery in 1895 put the student mind on the *qui vive*, and since the discoveries of Becquerel in 1896 and the Curies in 1898, radio-activity has easily held the center of the scientific field.

The mental processes and verifying experiments by which the cathode rays and the resulting "x-ray" phenomena and the emanations of radio-active bodies have been traced back to elementary electric units, of opposite signs, are complex enough and may not be of practical importance to physicians. But to follow these experiments gives us a peep at some of Nature's guarded secrets and may be worth while. Some of us have thought of Nature in a general way as a composite of matter and spirit. We may have loosely thought of electricity as a substitute

for the spirit element of the composite. At least we have often heard it claimed that vital processes are electric processes and neural currents are electric currents. If we accept the electronic theory, we must now think of ponderable matter as a form of electricity, while the essential nature of vitality and mind is as obscure as ever. The more we think of it the more this idea seems to harmonize with our observation of electric phenomena.

Whenever man has attempted to apply electricity to the wheels of industry his success has been signal; whenever he has attempted to apply electricity to the destruction of abnormal and parasitic life, his success has, at least, been partial; but whenever he has attempted to reinforce by electric energy, so-called, that energy we think of as vital, we can almost as truly say that his failure has been signal.

We do not forget that a flagging heart may be stung into temporary activity by a Faradic shock, a sensitive nerve vibrating pain may be soothed by galvanism and metabolism, may be influenced indirectly by static and high-frequency currents. But admitting this, other agents may serve as well to whip up a flagging heart, and the forceful impaction of hot and cold water may, indirectly, influence metabolism and modify nerve currents quite as surely. Indeed, it seems as if the wonderful fruits of recent scientific investigation had not added greatly to the physician's armamentarium. The more light we get the more it seems to be true that nature was kind enough to furnish man her richest healing agents — water, fresh air and sunshine — before he had learned the alphabet of science.

May we requote: "Electricity is not a form of energy any more than water is a form of energy. Water may be a vehicle of energy when at a high level or in motion; so may electricity."

Again it seems as if Nature had hidden from man and denied to his control life-destroying agents, among which electricity in motion may be counted, until he has reached, at least, the second grade in the school of science.

The phenomena of the x-ray are now fairly familiar to most of us. So familiar indeed that hardly a thrill of awe is felt as we look through flesh and blood to confirm or disprove a diagnosis about organs deeply covered and beyond the reach of any hitherto known light.

By the aid of that cleverly designed mechanism, the spinthariscope, we have watched the emanations of a minute particle of a radium compound, less than a hundredth of a grain, perhaps, and yet its seemingly exhaustless energy, its diamond-like brilliancy and the measure of its rhythmical scintillations made it seem as if we were looking at a microscopic reproduction of the great dog-star Sirius, — most conspicuous among "fixed stars" that glorify a winter's night. Our interest in the phenomena of this microscopic portion of nature is not alone because of its visual similitude to the grandest phenomena of the inorganic universe, but more to the significance of the testimony it bears to new truths concerning Nature of which we had not dreamed.

If it be true that radium, uranium and thorium are as surely elements as are bromine, lead and gold, and if it be further true, as seems proven, that these elements are being spontaneously transmuted into helium and other elements not yet identified,[19] then the whole theory of the indivisible atom and the unchangeable element, upon which so many scientific edifices have been builded, must, perforce, be discarded as misleading and outgrown.

If it be proved beyond question that matter may be reduced to electric monads, corpuscles, or electrons, each having a "mass" or "weight" one eight-hundredth and a bulk one hundred-thousandth that of an atom of hydrogen, and if we must think of the hydrogen atom as an aggregation of perhaps eight hundred electrons and the nitrogen atom with fourteen times as many, and the iron atom with fifty-six times as many, and each element with such a multiple of eight hundred electrons as corresponds with its atomic weight,[20] then, indeed, does the essential nature of electricity become a question of fascinating interest.

If we accept the theory that radio-activity is due to the explosion of atoms through the fierce energy of electrons within and think of these electric monads as mostly negatively charged, "flying about, each of them repelling every other, but all attracted and kept in their orbits by the mass of positive electricity in which they are embedded," imprisoned within the limits of a material atom, then we may better understand how the degree of radio-activity and atomic weight of a substance will be relatively small or large according to the number of electrons of which its individual atoms are composed.

If it prove true that radio-activity of elements and their compounds vary with the atomic weight — and atomic weight is determined by the number of electrons per atom — then we might, *a priori*, except animal organisms to be radio-active in a degree corresponding to those radio-active elements which enter into its composition. Experiments seem to show that certain animals are radio-active, but here the intensity of the radio-activity seems to vary with the vital activity of the animal, for we are informed by Lommasina[21] that the intensity of the radiation, or emission, is greater in grown birds than in young ones and greater in moving individuals than in those at rest.

And so it is that "bioradio-activity" calls for our attention. The call is low and uncertain, as yet, but it is a call to which our professional ears are better attuned. When nerve fiber and brain cells are found to register on calcium phosphide screens or specially prepared photographic plates[22] activities to which the human ear is deaf and to which the eye has hitherto been blind — then we may feel to say to the enthusiastic physicist, "this throws new light on physiology and is really worth while."

If members of this Society were to select a single name representative of American intellect

and scholarship from among the dead who live in our memory, to be written on the roll of fame with the best names of the old world, I fancy Oliver Wendell Holmes and John Fiske would each have some of your votes. Not a few of you knew the bright and genial "Autocrat" personally. Some of us who never looked upon his face loved him hardly less and almost envy you who were privileged to know him well. While the ripple of his graceful poetry and prose may hide the steady current of his scientific thinking, you know how few there were better conversant than he with the worth and the limitations of science. You know, too, how suggestive are some of his pages of a prescience of realities outside the boundaries of science proper — as if his soul had caught wireless messages concerning realities beyond the range of our imperfect organs of sense.

If the poetic temperament of Dr. Holmes would rank him among those kindred spirits whom Dr. Osler,[23] with apt metaphor, has called "the Teresians," those who see visions and dream dreams and walk not alone by sight — John Fiske truly must be classed with a different temperamental group. Not to the Laodiceans, surely, for we cannot conceive of the Cambridge philosopher as satisfied to "get and to beget," merely, nor could we think of his being lukewarm about any questions pertinent to "The Destiny of Man." His was pre-eminently the judicial type of mind. For many years in close touch with the best intellects of your own University at Cambridge, and not these alone, a graduate of the department of law; well balanced by nature, thoroughly trained in the laws of evidence, he applied himself diligently to collecting and correlating evidence, not alone of historical and political facts, but of facts from each of the physical sciences which, woven together, vastly enlarge our conception of that universe of which we are part.

If, then, we may further use the figure of Dr. Osler, John Fiske was a "Gallionion" by temperament and a scientist and historian by training. He accepted without reserve the essentials of the scheme of evolution as outlined by Darwin and elaborated by Spencer and others. His interest was intensely alert to the findings of science in the search for physical realities. He would have agreed with Lord Balfour [24] that "sense perceptions supply the premises from which we draw all our knowledge of the physical world. What we see depends not merely upon what is to be seen, but on our eyes. What we hear depends not merely on what there is to hear, but on our ears. Now eyes and ears have, as we know, been evolved in us and our brute progenitors by the slow operation of natural selection. And what is true of sense perception is, of course, also true of the intellectual powers which enable us to erect upon the frail and narrow platform which sense-perception provides the proud fabric of the sciences."

We dare to say that John Fiske would have indorsed the teaching of Lord Balfour because many of the truths forced home by the eloquent Chancellor of the University of Edinburgh had in different words and at different times been given to the world by the clear-headed teacher at Cambridge, Mass.

Lord Balfour's magnificent address to the British Association for the Advancement of Science at once fires our imagination and deepens our reverence. It cannot be otherwise. We catch the ring of scientific truth. We know the Premier's standing in the scientific world. We know by reputation the men whose experimental researches furnish his evidence. In the light of his marshalled facts we see, with the mind's eye, an all-pervading, space-filling ether which is not atmosphere or a gas, nor does it possess any of the properties of ordinary matter. Seemingly as intangible as the "mind stuff" of the older metaphysicians, we see this hypothetical matrix give birth to and support countless millions of electric monads which group into atoms of matter. Again we see, mentally, these numberless atoms "concentrated into nebulæ, into suns, and all the hosts of heaven." We see "how at least in one small planet they combined to form organic compounds; how organic compounds became living things; how living things, developing along many different lines, gave birth at last to one superior race; how from this race arose, after many ages, a learned handful, who looked round on the world which thus brought them into being, and judged it and knew it for what it was."

This is a partial epitome of the story of evolution so far as science has cut the leaves. Under the spell of Lord Balfour's eloquence it almost seems as if the whole story was told. Out of something nonmaterial, in the ordinary sense, science now postulates the creation of all material things. Emphasis is deservingly laid on the fact that our organs of sense, so well adapted to the lower planes of evolution, may limit as well as disclose realities which are and may forever be. Arthur Balfour does not claim even to outline the whole story. Indeed, he outlines what science does teach to make clearer, what true science doer not claim to explain. "One thing, at least, will remain, of which this long-drawn sequence of cause and effect gives no satisfying explanation," continues Lord Balfour, "and that is knowledge itself." Even as science must postulate an all-pervading entity called cosmic-ether to explain the most familiar phenomena of Nature; so must philosophy postulate a cognizing percipient called mind, without which all this molecular and intermolecular motion, which is the physical representation of life, could not be understood nor yet perceived. In the light of all the known facts does it seem incredible to you that Mind should be the objective towards which all the processes of evolution in Nature have been working through past eons? Does it seem a thing incredible that these organs of sense, even now less acute than those of animals on a lower evolutionary plane, should, in the further evolution of mentality, become less and less necessary to human personality?

I do not forget that my hearers are busy men, chiefly concerned in the science and art of medicine. These facts and fancies are somewhat foreign to our every-day work. And yet we know that underneath the professional current of many a busy physician's life are quiet depths where the testimony of Nature in all her phases are ever welcome. This has been my hope, and, if needful, this must be my apology. It has been my effort not to bring you a new or strange message, rather to gather from scientific fields and speculative by-ways such flowers of fact and fancy as seem most true and beautiful and most suggestive, when woven together, of the sublimity of Nature and the glory of that Eternal energy, which, in the language of John Fiske, "manifests itself to our consciousness, in harmonious activity throughout the length and breadth and depth of the universe, which guides the stars for countless ages in paths that never err, and which animates the molecules of the dewdrop that gleams for a brief hour on the shaven lawn, whose workings are so resistless that we have naught to do but reverently obey them, yet so infallible that we place our trust in them yesterday, to-day and forever."

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Original Articles.

REPORT OF RESULTS IN NONTRAUMATIC SURGERY OF THE BRAIN AND SPINAL CORD.*

OBSERVATIONS UPON THE ACTUAL RESULTS OF CEREBRAL SURGERY AT THE MASSACHUSETTS GENERAL HOSPITAL.

BY E. A. CODMAN, M.D.

I WANT to take this opportunity to thank the surgeons of the Massachusetts General Hospital for their kindness in allowing me to report these cases. I think that we all ought to appreciate the good will of the surgeons of the Boston City Hospital and the Massachusetts General Hospital in allowing us during the last two years to make use of their cases for discussion at these meetings. I fully realize, and I know that you, gentlemen of the society, also do, the great obligation we are under for the use of this material *used in the way in which we have used it* at these meetings. We have dragged up and brought to light the results of some very unsatisfactory classes of cases, and it is obvious that the statistics which have been shown at these meetings are somewhat less satisfactory than those which are reported by individual operators in other places.

However, during the last two years we have had ten good meetings on the present policy of presenting actual homemade results and of discussing the directions which improvements may take. Another thing which has developed from this search for results has been the construction of a system of tracing patients after their discharge from the hospital. Each of the younger men who has been kind enough to undertake to trace the results of these cases has contributed a little to the convenience of this system. As perhaps they may be of future service to others, I will mention the points which at present we find useful.

(1) To write to the friends of the patients at the address given on the entrance books of the hospitals.

(2) To write to the physician recommending the patients for admission.

(3) If we suspect that the patients are dead, their names may possibly be found in the State Archives, Room 432 at the State House. The cause of death is frequently given.

(4) The authorities in Room 36 at the State House have been most kind in giving information about the patients who have later gone to some of the public institutions.

(5) The town clerk at the place where the patient lived is often able to forward a letter to some relative.

(6) The police are always obliging in assisting to discover the present residence of the patients.

(7) Directories of many of the smaller towns and all of the larger cities are kept on file at the Dennison Manufacturing Company, 26 Franklin Street, or at the State House.

(8) People of the same name found in the directory in the town in which the patient resided may be written to to find out whether they have any knowledge of the case.

(9) In case the patient has moved his lodgings, the people in the neighborhood often know what his new address is, even if it has not been left with the postman.

(10) Occasionally the house officer who had charge of the case and whose name is found on the first page of the Record Book, will be able to tell of the result after the patient left the hospital.

These methods have all been used in tracing the present results, and we have been able to find the results in all of the cases operated on for epilepsy

*The following papers were read at a meeting of the Section for Surgery of the Suffolk District Branch of The Massachusetts Medical Society in conjunction with the Boston Medical Library, April 5, 1905.