SENSATION AND MOTION.

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Applying ourselves to the study of nature's phenomena, we are confronted by a vastness of variety, in which, nevertheless, the close observer cannot fail to recognize a multitude of analogies. Forms vary, and at the same time express some kinship; modes differ, and still present similarities; the dazzling kaleidoscope of life reveals its causality; complexities evolve from units, and we begin to realize an all-embracing entity, appealing to us like endless variations of an eternal theme, which is often distinctly felt, more often but vaguely suspected. We become philosophers, scientists and artists, striving to learn to explain and to apply, and finally recede to the fundamental question, "what is life, what is energy?"

In order to gain a broad knowledge of things, we must not be specialists; it is not enough that we explore, analyze and test, we must also compare, recognize and conclude. Philosophic speculation has often born out metaphysical monstrosities, because it had lost touch with the reality of things, but scientists have tended to fall into the other extreme, and while they were compiling data, their views for wider scopes became more and more clouded. Facts revealed by experiments are highly valuable, not so much in themselves, as in opening the gates to those who are capable of abstracting them into far-reaching conclusions or theories. Any theory which adjusts itself with ease to explain the greatest number of phenomena, stands indeed next to a law of nature. All natural laws are, or at least have been, theories at one time.

Approaching the topic of vital functions among which that of the human mind stands preeminent we study its substratum, the nervous system, and appreciate the work done by anatomists, who with the aid of microscope and staining-methods have given us

an idea of its wonderful make-up. But morphology is too limited and therefore does not give us complete satisfaction. We may, with the aid of better microscopes, be able to see more delicate forms, but the best microscope will not reveal to us the soul of form, or that inherent energy which expresses itself in the display of form. We resort to physiology and biology, as these branches of science promise a better understanding of the animate world, but soon we realize that in order to understand the complicated, we must have an understanding of the simple, and it becomes imperative, that we take recourse to those sciences which deal with the elementary properties of substance in general.

Herbert Spencer defines "Life" as the continuous adjustment of internal relations to external relations; now let us consider substance in general, and see, whether that dictum may be extended to the so-called inanimate world. Life as well as energy are manifestations which cannot exist independent of substance. What we call life in the animate has its analogon in the energy of the inanimate. Energy is the intrinsic property of all substance from which it cannot be separated. Energy in its various forms can be traced to the common root of motion. It is a universally accepted theory that the various forms of energy known to us, for instance, as heat, light or electricity are definite modes of motion of infinitely small particles of substance. Motion then is the ultimate unit, and at the same time the limit of an objective conception of energy. But, although we have reduced the various forms of energy to vibrations of substance, although we have ascertained with mathematical precision, their velocity and wave-lengths, have we thereby advanced one step toward the explanation of sensory phenomena? We may, for instance, define light as a mode of motion, but what conclusion can we derive from that to explain light as a mode of sensation?

To attempt an explanation of the phenomenon of sensation, which is so indispensable in our conception of life, we may consider energy under two relative denominations, namely, objective and subjective; or energy objectively manifest as motion, and subjectively manifest as sensation or sensibility. Motion then becomes the objective aspect of that which is only subjective, namely, sensation.

In the event of our ego we realize an exquisite sensory phenom-

enon. All our perceptions, our thoughts and emotions, even the motions of our body and the cognizance of our existence are to us modes of sensation. The life of each individual is in itself a series of sensations of a more or less complex character.

Now imagine an atom and its intrinsic energy ; we know it only from its objective aspect, which reveals its existence ultimately, as a body in motion ; of its subjective existence we know nothing, unless we imply it by analogy. Now let myriads of atoms gather to build up the nervous system of a living being, and there is brought into existence an ego, which has sensation toward which each of the constituent atoms has contributed its share. If millions of atoms make up an organism which has sensation, why should we deny sensation to the individual atom, be it ever so minute? To assume atomic sensibility is only a logical conclusion, but by no means a novel one. As organization ascends in evolution, we see complexity and coordination, of motion and sensation, simultaneously rise to higher perfection ; both phenomena are so inseparable, that we are forced to the assumption that motion is the objective expression of sensation, which is always subjective.

After having conceded sensibility to the unit of matter, because we found sensibility in the coordinate complexity of units, the organism, we may proceed to illustrate the relation of sensation to motion.

A vibrating tuning-fork, for example, is objectively a body in motion ; by its immediate contact with the surrounding atmosphere, it sets the latter into motion, producing definite waves, while each atom, or group of atoms, evokes similar motion in its neighbors, until perchance the acoustic nerve, and along it the centers of hearing in the brain are reached. At that moment the vibrations cease to be objective, they become subjective, and at the very instant when they change their relative denomination from the objective to the subjective, they change into sound. The appreciation of sound is a phenomenon of life, it is, to express it in the language of Herbert Spencer, the adjustment of an internal or subjective relation to an external or objective relation ; in other words, it is an example of the adjustment of sensation to motion.

As a matter of fact, each of us is cognizant only of his own sensorium ; he knows nothing of the sensations of his fellow creatures,

unless he imply them by analogy. How then, is it possible, that one person may communicate a sensation to another person? He must give his sensation an objective aspect, he must translate it, so to speak, into its objective form, in other words, he must express it by an equivalent of motion. And whereas sensation as a subjective phenomenon is not directly transmissible, it becomes so indirectly in form of motion which constitutes its objective equivalent.

In connection with the foregoing more general considerations we may now try to elucidate in detail one of the most important sensory phenomena, namely, visual perception.

Visual perception may be defined as the definite sensation caused in an individual by communicating to him a definite mode of motion or vibration, known as light. We know, that the vibrations produced by an electric current in the wire of a glow-lamp are realized by us as sensation of light. Now let us prove, that the parenchymes of those nerve cells, engaged in the sensory act of seeing, do at the same time perform a motor act by originating vibrations commensurate to those of light.

To that purpose we may derive much aid by scrutinizing a trivial experiment. If one, after having looked for a while at an evenly colored object, for instance, a red disc, suddenly directs his view toward a white wall, he will perceive an image of the disc on the wall; but instead of seeing it in the original red color, the image will present itself in the complementary color "green." It may be remembered here that colors are called complementary to each other, if on addition they compose the color "white." Let white be represented by vibrations of 1000 velocity in a definite unit of time; red, as a fraction of white, be represented, arbitrarily, by vibrations of 100 velocity in the same unit; green, will then, as the complementary color to red, have to be symbolized as vibrations of 900 velocity. While looking at the red disc, the intracellular vibrations of the centers of sight in the brain adjust their vibrations to a velocity of 100, and the sensation "red" is realized; if now the red disc be suddenly supplanted by a white surface, from which emanate vibrations of 1000 velocity, the intracellular vibrations, which were up to that time of 100 velocity, have to be increased by 900 in order to adjust themselves to the vibrations of 1000 coming from the white surface. The addi-

tional intracellular vibrations of 900 velocity are the motor equivalent of the sensation "green." Thus is given a comprehensive explanation of the production of complementary colors in after-images, although this conception of the phenomenon deviates materially from the theories in vogue at the present time, and besides this experiment furnishes an example of a motor act during a sensation.

But there is a more unique method of proving the coexistence of intracellular motion during the act of visual perception. With the aid of a suitable apparatus, which will be minutely described in a later article, we are enabled to take photographs of emanations coming from the eye during the act of visual perception.

It is very probable that vibrations emanate from all nerve-centers at all times, that they are most active during consciousness, and that those from the organs of sight are similar to light-vibrations. During visual perception the rays entering the eye from a source of light disturb the equilibrium of those nerve-vibrations emanating from the optic nerves, consequently, they must adjust their mode in order to balance the mode of motion impinging from without. The increased efflux of energy which restores and maintains the equilibrium between afferent light-vibrations and efferent nerve-vibrations, is subjectively appreciated as a sensation of sight, whereas, objectively, it constitutes a mere motor phenomenon. The outflow of nerve-energy over the optic nerve has an analagon in the continuous efflux of nerve-energy which maintains the tonus of a muscle, and which may, during a definite sensation, be exaggerated to such an extent as to produce forcible contractions of the muscle.

Thus far we have only spoken of that kind of visual phenomena which have an adequate cause outside of the organism, and it seems proper now to mention visual phenomena devoid of an external cause and known as visual hallucinations. Since visual percepts are capable of exciting the emotional sphere of the mind, it is easy to understand that the reverse should be true, and that emotions may evoke their equivalents in the visual regions of the brain; the visions thus produced are not percepts, but hallucinations. It is not a coincident that hallucinations occur exclusively during a state of increased subject-consciousness and abate object-

consciousness of the individual at a time when nervous emanations from within partially or completely overbalance all impressions from without, so that perception, or the adjustment of internal relations to external relations is no longer possible. Then the overpowering subjective feeling pours out streams of nerve energy, and while they traverse the regions of the brain, which in the normal state of mentality pertain to vision, they are formed into sensations of sight. The only difference between visual perceptions and visual hallucination is, that during the former, those nerve-vibrations from the brain are adjusted to light-vibrations from without, whereas, during the latter, the vibrations produced by the nervous system are so powerful that they overbalance the rays of light from the outer world.

Returning to Spencer's definition of Life, which we interpreted, after some elaboration, as the continuous adjustment of subjective relations, or sensation, to objective relations, or motion, we behold the principles of life everywhere, since every adjustment or reaction comprises in itself the elements of sensation, or that inherent power of discrimination, which we meet in the highest forms of life as individual consciousness. Motion reveals itself merely as the means by which nature expresses and communicates sensation; sensation is the soul of all existence, motion is the image; and if motion prevails throughout the universe, it only proves that sensation is omnipresent.