physical principles; it has been abundantly tested by experiment, both on a small scale in the laboratory, and, as we may say, on a large scale in nature; it is universally accepted by men eminent in physical study, whose original ability and careful, studious work have led them to be regarded as authorities in their science, but who, being authorities, have not thereby become arbitrary and irrational. It is therefore difficult to understand why the question should be so confused by Hazen in the *American Meteorological Journal*, September, 1889."

We have already seen that these so-called authorities have tried no personal experiments,—at least, Ferrel does not allude to any such experiments,—and have been entirely misled by a few crude and contradictory researches. Is it not high time that this appeal to authorities be done away with? One of the main arguments advanced in support of storm theories is that such men as Ferrel, Hann, Mohn, and a host of others, are agreed,—agreed, however, as we have seen, upon exceedingly unsatisfactory evidence. Professor Davis suggests that these theories rest upon experiments, "as we may say, on a large scale in nature." This certainly is far from the truth. All the reasoning regarding the diminution of temperature in dry and moist air as we ascend in the atmosphere is founded upon purely theoretical considerations. Every experiment, whether in the laboratory or in nature, has proved that these theories, in their sum and substance, are false. But there is no use in arguing this question. I am so confident of my position in this controversy, and have become so deeply interested in studies regarding it, that I propose risking a little money upon it.

I will give a hundred dollars to the first physicist who will show that Espy's observations and experiments with the nephelescope, as published in his "Philosophy of Storms," giving the effects of expansion in moist and dry air, when properly interpreted, prove his theory.

It will be necessary to show,—

1. That the rise of mercury in the gauge after expansion was entirely due to heat from outside.

2. That the speed of expansion Espy used, or the amount of cooling from expansion, was comparable to the probable speed of expansion in the free air.

3. That by placing water in the bottom of the nephelescope the air would be saturated.

4. That air, under the conditions observed by Espy, will lose its dew-point or become unsaturated to the extent of four or five degrees in twenty hours.

5. That the cloud Espy observed was not largely formed by dust pumped into partly dry air.

6. How, if the heat liberated on condensation of the moisture is used in performing the work of expansion, there can be any heat from that source for expanding the air.

7. Why, if there is any latent heat set free on condensation in saturated air, it would not at once re-evaporate the condensed moisture, or heat the surrounding air to an unsaturated state.

8. That if latent heat is set free on the formation of a cloud in the nephelescope, its effect does not disappear at the moment the cloud disappears, provided none of the moisture settles to the bottom or sides of the nephelescope.

9. By means of delicate thermometers, that there is not practically the same effect upon the air, as regards heat, in expansions like these, whether we use dry or moist air, or, what is the same thing, disprove the experiments and statements made in the *American Meteorological Journal*, September, 1889.

[Continued on p. 358.]

MENTAL SCIENCE.

Motor Hallucinations.[1]

THE hallucinations most frequently recognized are those of sight and hearing. Something is seen that has no objective existence, or something is heard when no sound is made. There is, however, another form of hallucination to which attention has been directed. In the hallucinations connected with language, all these varieties are evident. Imaginary words are seen or heard, and they may also be felt as movements. One patient, subject to all kinds of hallucinations, perceived internal voices compelling her to do and say things against her will; but there was no sound emitted, and the patient perceived the sense of the words by the movements impressed upon her tongue. Several other cases have been reported in which messages are received, not by sight or hearing, but by the feeling of movements in the articulatory apparatus. In one case this was unaccompanied by any other mental defect, so that it was a pure case of verbal hallucination of this motor type. This hallucination has its seat probably in the third frontal convolution, the same part that is affected when motor aphasia sets in, — a condition in which the patient is able to understand written and spoken words, but is unable to give expression to his thoughts for lack of the association between the words and the motor feelings in the organs where those words are to be formed. The hallucination thus arising may be of various degrees of cogency: it may be entirely sensory, or there may be slight movements of the articulatory apparatus, or there may be an irresistible tendency to speak the words that are imparted to the tongue. Moreover, there sometimes occurs the hallucination that the patient is speaking, and yet he utters no word. Here there is in part an auditory hallucination, but also in part a motor one; for the patient has the feeling of having made the movements necessary for speaking the words.

While the special development of speech makes the motor hallucinations of speech unusually prominent, they are by no means limited to this type, but may occur in any field of motor action. While sleeping, we often have the feeling of going through fatiguing and complicated motions, when in reality no movement takes place. This is likewise to be referred to a stimulation of these cortical centres. Similarly we dream of falling down a precipice or of flying, — hallucinations equally frequent in insanity. It is not unlikely that this was the basis of the flights through the air of the witches and those possessed. A special class of these sensations arising from the stimulation of a central organ is to be found in cases of amputation. It is well known, that, when an arm or a leg has been lost, the person still retains all the feelings of the lost member. The hallucination is at times so definite that the clinching of the separate fingers may be felt, though the arm and hand have been gone for years. Out of ninety cases, there were only four who did not describe these hallucinatory sensations. While these hallucinations are in part sensory, there are also motor. Some feel the movements in the absent hand, describing its position as in the act of grasping, of writing, and so on. The seat of these sensations is doubtless in the brain and in those portions from which the innervation impulses arose when the limb was intact.

With regard to the genesis of the hallucinations, we seem warranted in assuming three stages in their formation. The first is central, and consists in forming a sensory image of the movement; the second is centrifugal, and consists of an impulse from the centre to the muscles and nerves; the third is centripetal, indicating that the peripheral organs of locomotion have undergone the changes due to the movement. That the last stage is not necessary to the production of the motor hallucination is shown in the case of the amputated limbs and elsewhere. We

[1] M. Tamburiai, in Revue Scientifique, May 10, 1890.

find, too, that all of the types of motor hallucination are explicable as central irritations of these centres, in which these different factors are present in various degrees. The nature of these centres would in each case be both sensory and motor; and the hallucination, if properly analyzed, would also be of the mixed form.

Color-Vision and Color-Blindness.

Mr. R. Brudenell Carter,[1] in a lecture before the Royal Institution, outlined the position of modern science upon this important topic, and from his remarks the following points may be selected: the perceptive layer of the human retina consists of rods and cones; in the centre of the retina, only cones occur; in a ring around this, each cone is surrounded by a circle of rods; and as we recede from the centre, the proportion of rods to cones becomes larger and larger. There is good reason for believing that color-vision is limited to the cones, and certainly the perception of color is best where the cones are most numerous. Nocturnal animals have a less perfect development of cones than diurnal ones. The limitations of the color-sense on the human retina are very considerable. The color-sense is complete for three fundamental colors of the spectrum for not more than thirty degrees of the field, is limited to red and violet in a small ring outside this field, and from there on is sensitive only to differences of light and shade. In the lower animals, especially in those having their eyes more on the side of their heads and possessing acute vision, we find a power of perceiving colors over a much larger area of the retina; and this is associated, as has been shown in birds, in some reptiles, and in fishes, with a more abundant and more even distribution of the cones over the retina. There has recently been observed upon the cones of some birds, globules of a colored oil, which transmit only light of their own color; and green, orange, and red drops prevailed in the birds examined. Why this is so remains to be determined.

When the condition that exists normally in the outer zones of the retina exists also in the centre, we have color-blindness; but such a degree of color-blindness is rare, if indeed it exists at all. The more common defect is that which exists in the zone surrounding the fovea; that is, a blindness to green. Such persons can distinguish violet and yellow, and they can see red, but cannot distinguish it as a color from green. The most common defect, however, is a blindness to red; and an extremely rare form is blindness to violet. The Young-Helmholtz theory regards the defect in the red-blind person as a paralysis or an absence of the red-perceiving elements in the retina. To such a one, spectral red is not absolutely invisible, but appears as a green of feeble luminosity, and the brightest part of his spectrum is in the blue-green. When green stimulates the eye of the green-blind, there results the white of the green-blind, which to ordinary eyes is sort of rose-color. To both red and green blind, then, these two colors are indistinguishable, the only difference being that to the red-blind the red, and to the green-blind the green, seems, in comparison with the other, of feeble luminosity. By looking at colored objects through a glass of peacock-blue the colors will appear somewhat as they do to a red-blind person, and by looking at them through a purple glass they will appear somewhat as they do to the green-blind. These defects exist in about four per cent of the male population, and in about one-tenth of one per cent of the female.

With regard to the dangers resulting from the placing of color-blind persons in responsible positions, it is easy both to exaggerate and to underestimate them. We naturally think of the railway and marine service, in which colored signals are used; and it is certain that a considerable number of those thus employed suffer from this organic and therefore incurable defect. We would be apt to think that such persons would at once reveal the defect, and thus be released from duty. We must remember, however, that the existence of this defect remained unknown until about a hundred years ago, and that it is often concealed by the correct use of color-names, — a rather easy art for the color-blind to acquire. And, again, these persons always know where to look for a signal, and hence under ordinary occasions the slight distinction they make between red and green, aided by good luck, may be sufficient to avoid accidents. The methods of testing and discovering this defect are various, but they all depend upon matching colors and avoiding the use of color-names in the process. There are all degrees of the defect, from a tendency to confusion of dark greens and reds and a hesitation in deciding between them, to absolute indistinguishability of pronounced shades of them. The necessity of an examination in all posts in which color-distinction is necessary is now recognized, and governmental regulations upon the matter have been largely adopted. It may be advisable to add that there is a form of imperfect color-perception not at all related to color-blindness, but sometimes confused with it. It is simply a lack of practice and of training in color-distinctions. It is quite surprising with what ignorance of colors and their various shades children may grow up. This is a thing that may be taught, and is now frequently introduced into primary education.

[1] See Nature, May 15, 1890.

NOTES AND NEWS.

AMONG the geographical expeditions which are decided upon for next summer in Russia, one is of unusual interest, that to the Black Sea. The physical features of this important and deep basin are so little known that we have little information on the depth at even a short distance from the shore. As to the temperature, salinity, etc., of the water at great depths, we have only a few observations along the eastern coast by Professor Lapschin, and near the entrance to the Bosporus by Count Admiral Makarow. Last winter, Professor Klossowsky and Dr. Andrussow, in a memoir addressed to the council of the Imperial Russian Geographical Society, showed clearly the importance of an investigation of the deeper part of this sea. It was warmly supported by the society, and the Ministry of Marine sends a vessel for this purpose on a cruise of a month's duration. The nautical part of the scientific work will be under the direction of Capt.-Lieut. Spindler, while the Geographical Society sends Drs. Wrangell, A. Woeikof, and Andrussow, the last mentioned of whom will have charge of the botany and zoölogy.

—The Elizabeth Thompson Science Fund, which has been established by Mrs. Elizabeth Thompson of Stamford, Conn., "for the advancement and prosecution of scientific research in its broadest sense," now amounts to twenty-six thousand dollars. As accumulated income will be available December next, the trustees desire to receive applications for appropriations in aid of scientific work. This endowment is not for the benefit of any one department of science, but it is the intention of the trustees to give the preference to those investigations which cannot otherwise be provided for, which have for their object the advancement of human knowledge or the benefit of mankind in general, rather than to researches directed to the solution of questions of merely local importance. Applications for assistance from this fund, in order to receive consideration, must be accompanied by full information, especially in regard to the following points: 1. Precise amount required. Applicants are reminded that one dollar is approximately equivalent to four English shillings, four German marks, five French francs, or five Italian lire. 2. Exact nature of the investigation proposed. 3. Conditions under which the research is to be prosecuted. 4. Manner in which the appropriation asked for is to be expended. All applications should reach before December, 1890, the secretary of the board of trustees, Dr. C. S. Minot, Harvard Medical School, Boston, Mass., U.S.A. It is intended to make new grants at the end of 1890. The trustees are disinclined, for the present, to make any grant exceeding three hundred dollars: decided preference will be given to applications for smaller amounts. A list of the grants hitherto made, amounting to about six thousand dollars, is given in a circular just issued by the trustees.

—The American Swedenborg Printing and Publishing Company of this city are issuing the more important of Swedenborg's writings in clearly printed pocket volumes. "Angelic Wisdom concerning the Divine Love and the Divine Wisdom," the latest issue from their press, is a model of neatness and of good book making.