in order to get rid of these irregularities, to get together a larger number of observations. This is done by simply adding together all the first halves and all the second halves: that is, in this case, I have added columns, etc. As I understand it, exception is taken to this operation, as bringing together quantities which are not homogeneous. Suppose that, instead of adding up directly each half of a series, the mean rainfall at a station is obtained from the whole series. Now, if the proposition as above stated be correct, this mean rainfall is, barring irregular fluctuations, the rainfall of the middle year of the series. Let the residuals be taken. Is there any impropriety in adding up the residuals, not only in each half-series in one sum, but those of all the half-series, for comparison of the sums of the two half-series?

Or, to put it in mathematical form, let R equal the mean rainfall of a series, which is equal to the rainfall of the middle year, r the rainfall at any time, t the interval in years before or after the middle year (plus when after, and minus when before), x equal the rate at which the rainfall is supposed to increase, which may be assumed as constant over the area, as it is a qualitative rather than a quantitative result which is sought. We desire to learn whether x has any considerable value. Then

$$r = R \pm tx, \text{ and } x = \frac{r - R}{\pm t};$$

and, for a single series,

$$x = \frac{r_1}{t_1} + \frac{r_2}{t_2} + \frac{r_n}{t_n} - \frac{r^1}{t^1} - \frac{r^2}{t^2} - \frac{r^n}{t^n},$$

the mean rainfall R being eliminated: x being the same over the entire area, and the mean rainfall being eliminated, the above equation applies to all series, and they may be properly combined for the purpose of obtaining the value of x, and

$$x = \left[\frac{r_n}{t_n}\right] - \left[\frac{r^n}{t^n}\right].$$

As has been stated, this method was used to test the above proposition, in the prairie region. Twenty-four stations were used, and the observations of 428 years were used in evidence. The result showed that there was a trifling amount *more* rain in the earlier than in the latter half of the series. In short, it showed that the rainfall had not increased.

It was applied in Ohio, which from a forested area has become with settlement mainly a deforested area. Under the terms of the proposition, the rainfall should have diminished, but the amount of the diminution is trifling, being but .21 of an inch per year. To this result twelve stations, with 294 years of observation, contributed.

Southern New England, comprising some 20,000 square miles, was originally a densely forested region. With the progress of settlement it was almost entirely cleared. In recent years, say since 1860, a reverse movement has been going on. The competition of Western farms and cheap transportation is driving New England farmers to other vocations, or is forcing them to move to other parts of the country. Thus the farms are being abandoned, and are growing up to woods. To-day Massachusetts contains 52 per cent of woodland, and Rhode Island even more. Southern New England, then, presents two phases of change for investigation. During the earlier period, with the cutting-away of forests, the rainfall should have diminished, while during the past twenty-eight years it should have increased. During the first period there were used in the investigation eighteen stations, with 400 years of observation. The examination showed that the rainfall had *increased* while deforesting was going on.

In the second period fourteen stations were used and 200 years of observations. The examination showed no change whatever.

This investigation has convinced me that forests exercise no influence whatever upon rainfall. I wish to state this plainly, as it was suggested at the last meeting that I had some doubts concerning the results obtained. I regret that any thing in my paper should be capable of such a construction, as it was certainly as far as possible from my thoughts.

I am aware that this conclusion is at variance with the popular idea, and that a popular idea is not a thing to be disregarded, as there is usually some reason for its existence. We find woodland and a heavy rainfall generally co-existing. In almost all places enjoying a heavy rainfall, the land is covered with forests, unless they have been removed by man. It may be that in this case an effect has been mistaken for a cause, or rather, since it is universally recognized that rainfall produces forests, the converse has been incorrectly assumed to be also true.

Although forests have no influence upon precipitation, yet they do exert a certain economic influence. Without increasing rainfall, they, in common with other forms of vegetation, economize that which falls, retaining it somewhat as a reservoir, and preventing its rapid descent into the streams. In this way, too, forests tend to reduce the magnitude of floods and to regulate the flow of rivers, thus preventing disaster and improving navigation. This retention of the rainfall is, however, accompanied by a rapid evaporation from the leaf surfaces of the forest, whereby a considerable proportion of the rainfall returns to the atmosphere without reaching the earth. On this account it is urged, and I think with reason, that in our arid region, which is dependent for irrigation upon its streams, it is advisable to cut away as rapidly as possible all the forests, especially upon the mountains, where most of the rain falls, in order that as much of the precipitation as possible may be collected in the streams. This will cause, not a decrease in the annual flow of the streams, as commonly supposed, but an increase, coupled with a greater concentration of the flow in the spring months, and result in rendering fertile a greater area of the arid region. It may be added that the forests in the arid region are thus disappearing with commendable rapidity.

There is no question but that forests reduce the extremes of temperature in their immediate neighborhood. They also serve mechanically as windbreaks, diminishing the force of air-currents. In these and perhaps other ways they serve a useful purpose.

But with all this in mind, is it worth while to go on planting trees for their climatic effects? It seems to me, that, apart from the uselessness of it, nature is planting trees at an infinitely more rapid rate than man. For every tree planted under the timber-culture act, or on Arbor Day, a thousand spring up of their own accord. Every deserted farm east of the plains grows up to forest. Half of southern New England is to-day wooded, and the proportion is increasing every year, and yet in Massachusetts they have every year an Arbor Day, when the farmers turn out and solemnly plant a tree apiece.

MENTAL SCIENCE.

The Psychology of Deception.[1]

THE deceptive character of the evidence of the senses has become attributed to them because of the failure to recognize that we seldom have to do with a simple sensation. What deceives is not the information of the sense, but the wrong interpretation of this information by the mind. Such interpretation need not be conscious, and often is not so. The familiar experience of raising a pitcher of water, usually well filled but upon the present occasion empty, and finding it dart upwards in our hands, is a case in point; for it shows that we estimate the amount of force necessary to raise the pitcher, but only become conscious of this inference when it happens to lead us astray. The phenomena of the stereoscope abound in illustrations of such unconscious reasonings. One of the simplest types of deceptions arises when such an inference, owing to an unusual disposition of external circumstances, leads to a conclusion that better evidence shows to be false. A ball held between two crossed fingers seems to be double, because under ordinary occasions an impression on the right side of one finger and on the left side of its neighbor (to the left) could only be brought about by the simultaneous contact of two objects. Everywhere, then, we interpret the unfamiliar by the familiar, the unknown by the known: illusion arises when the objective conditions change their character, and real deception occurs when this change is not recognized, when no better evidence is present to antagonize the false inference. The child who regards a spoon half immersed in water as really bent,

[1] See an article with this title by Joseph Jastrow, Ph.D., in the *Popular Science Monthly*, December, 1888.

the moon high up in the sky as really smaller than when near the horizon, presents a case of such deception.

No better instances of deceptions depending upon unusual objective arrangements can be found than the ordinary conjuring tricks. Here deception depends solely upon an ignorance of the devices employed. When ink is turned into water, when two half-dollars are rolled into one, when a box in which you have just placed an article is opened and found to be empty, or when a card suddenly changes from one face to another, deception takes place when the spectator is ignorant that a chemical can change the color of liquids, that one half-dollar is hollow and allows the other to fit into it, that the box has a double bottom, and the card a flap, that, falling down, shows another aspect. These objective arrangements are often much more complex, and the conditions that ordinarily lead to correct inferences are imitated with remarkable ingenuity. The accepted rule of conjuring, to always first actually do that which afterwards you desire the audience to believe you have done, shows keen insight into the workings of the mind. When coins are caught in the air and thrown into a hat, a few are really thrown in ; the others palmed in the hand holding the hat, and allowed to fall when the other hand makes the appropriate motions.

Leaving the objective conditions of deception, and turning to the subjective, the psychological interest is deepened. If our condition departs from the normal, however slightly, and we fail to recognize the variation, illusion is apt to arise. The phenomena of contrast and fatigue are simple cases in point. Fatigue the eye for red, and it sees white light as green. Plunge the hand from hot water into luke-warm water, and it will feel the latter as cold. When a disturbed mental judgment is present to misinterpret such unusual sensations, illusions of a very serious type may arise. But even within the limits of normal judging powers, the emotions, the interest, expectation, can alter the nature of a sense impression. In all perception two factors contribute to the result,— the attitude of the percipient, and the nature of the object perceived. When the naturalist observes what the stroller overlooks, or the sailor detects a distant sail when the landsman's eye sees nothing, it is because the former knows what to expect. When expecting a friend, any indistinct noise is converted into the rumbling of carriage-wheels, as the mother hears in every sound the cry of her sick child. The conjurer, taking advantage of this, creates an interest in some insignificant detail, and draws the attention away from the real trick. His wand, his motions. his talk, are all intended to give him a favorable moment for doing the real trick before the unobserving eyes of the spectators. When he counts 'one, two, three,' centring all the emphasis upon 'three,' and thus focusing the attention of the audience upon that instant, he does the real transformation at the unattended 'one' or 'two.' The conjurer's art is largely composed of devices for misleading the attention: a trick is successful according to the setting that the performer can give to it.

In one point, however, the conjurer's performance fails to illustrate the psychology of deception. The attitude of the spectator is too definite. He knows that he is being deceived and has nothing at stake. Quite different was it when such a performance carried with it a belief in the magical and mystical, when the spectator believed himself in the presence of powers that could be turned against him and his welfare. The best parallel to this attitude in modern times is seen in the physical phenomena of Spiritualism. The medium performs to sitters in doubt as to the true explanation of the phenomena, or more or less ready to credit every thing to the supernatural. Such an expectation can see a miracle in the simplest conjuring tricks ; and more than once have professional conjurers been declared to be mediums in spite of all protests from themselves. The general rule at the séance, where the emotions are strung to the highest pitch, and the judging faculties labor under the worst conditions, is that the spectators see whatever they are interested in seeing. The same form is recognized by various spectators as the spiritual counterparts of totally dissimilar persons. Only let the form be vague, the light dim, the emotions at a strain, and what is lacking in the object will be supplied by the imagination of the spectator. In the same phenomena each finds proof of his own pet beliefs, until the refusal to mistrust the evidences of an excited consciousness leads to actual mental disorder. The records of the witchcraft delusion show the same result: the facts are seen in the light of the prevailing theory. "With the doctrines of modern Spiritualism to be supported, the number of mediums and manifestations will be correspondingly abundant. Create a belief in the theory, and the facts will create themselves."

To all this must be added the enormous influence of mental contagion. Wherever a subjective influence contributes to the resulting deception, contagion plays a part, — fear, panic, fanaticism, superstition, all flourish in crowds. The witchcraft delusion and the spiritualistic movement show to what dimensions psychic beliefs can attain when fanned by the flames of emotional enthusiasm. If, in addition to all this in which self-deception plays the leading *rôle*, we add the variety of illusions carried on by conscious fraud, we may perhaps appreciate the enormity of error through which civilization has made its way. Such errors are destroyed, not by logical disproof, but by rendering unsuitable the soil upon which they flourish.

THE ALLEGED EVOLUTION OF COLOR SENSITIVITY.[1] — To test the theory frequently met with, that in the thirty centuries of civilization the human retina has developed a gradually increasing color perception, — the homeric man seeing chiefly the red end of the spectrum, and blue coming in much later, — M. G. Pouchet compared the proportion of color epithets in types of the literature of various ages. He selected (1) a very recent work of M. Guy de Maupassant on water, (2) 'Paul et Virginie,' as typical of the beginning of the century, (3) Books I. and VII. of 'Telemaque' for the same reason, (4) Chapters XIV. to XXII. of the second book of 'Pantagruel,' taken at random from 'Rabelais,' and (5) a short romance, 'l'Ane,' attributed to Lucian. (1) gave the following number of color appellations: white, 21 times; black, 14; gray, 3; brown, 4; all kinds of reds, 23 (including pure red — 15); yellow, 5; green, 6; varieties of blue, 17 (in which pure blue occurs 12 times); and violet, 3 times; in all, 96 terms. Taking only the primary colors, we have red, 26; blue, 17; green, 6; yellow, 5; and violet, 3. (2), though more extended a work than (1), gave the following: white, 13; black, 15; gray, 1; varieties of red, 11; varieties of blue, 7; of green, 8; yellow, 1: or red, 11; green, 8; blue, 7; yellow, 1. (3) gives black, 2; white, 2; red and shades, 4; green, 2. One might add golden, 2, and reddening, 2; and would thus have red, 6; yellow, 2; green, 2. (4) gives black, 1; white, 3; red and varieties, 7; green, 2; blue, 1. (5) gives but one name, red. The result is that writers show a marked tendency to describe red things, and this tendency holds good for all times. If we survey the ordinary color impressions to which the retina is exposed, we find, first, a general brightness involving all colors, — the blue of the sky, the reds of sunrise and sunset, the whites and grays of clouds; words expressive of these abound. Considering next colors in which whiteness does not enter, we find that a true violet is extremely rare in nature. Blue, too, is little fitted to be physiologically conspicuous as it presents itself in nature. Yellow is more extended, especially on flowers, but it loses its individuality in a general whiteness. There remain green and red. The reason why red has acquired so striking an effect is, that, owing to the preponderance of green, the red is conspicuous by contrast. Again, red, as the color of blood, as the symbol of fire, as the color first and most sought after in dyes, would soon acquire a moral and intellectual prominence that would lead to its frequent mention. The proper conclusion, then, is not that our ancestors were unable to see blue and its allied shades, but that they followed the natural tendency to describe what was prominent, and this coincides with the red.

THE MENTAL POWERS OF THE APE. — According to a recent letter to the London *Times*, Mr. Romanes has succeeded in teaching an ape to count; not merely to detect differences of number, but to associate different groups of sensations with vocal sounds. Fearing that if too complex the experiment would entirely fail, the counting was attempted only up to five. By refusing all but the number of straws asked for, and rewarding the ape for a correct performance, the creature was taught to give at command one, two, three, four, or five straws. His method is to take the straws one by one into his mouth, until one less than the required number have been collected; then, taking up an additional straw, he hands it over, together with those in his mouth, — certainly a remarkable performance.

[1] *Revue Scientifique*, Oct. 13.