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Contents.

(Illustrated articles are marked with an asterisk.)

WHAT DO WE SEE?

Not a little comment has been provoked by the recent article entitled "The Trustworthiness of the Senses," in the course of which we expressed the belief that in health our senses are truth-telling and trustworthy, and that the cases commonly cited as illustrating sense deception, or deception by the senses, are really instances of mistaken judgment. The sense does not tell us a lie, but we infer what is not true through haste, carelessness, or lack of knowledge. Accustomed to associate certain conditions with certain appearances, for instance the presence of a gem when a particular play of light and color is perceived, we infer the existence of the familiar condition whenever the usually ascribed phenomenon is observed. We see the play of color, and pronounce its source a gem. On examination, we find that there is no gem, but merely an angular cavity in bright metal bathed in clear or colored light. The eye was deceived and reported a lie, men say: not so, say we; the eye reported the appearance correctly; it was not within its province to tell what caused the appearance. Our erroneous inference arose from lack of knowledge of the fact that that particular play of light could be produced in various ways other than the refractive action of a particular gem.

Such misleading inferences are frequently made by microscopists; bubbles are mistaken for solids, solids for cavities, transparent globules for opaque masses, and so on, the liability to error lessening with increase of experience and knowledge. A notable instance occurred but a little while ago. A mineralogist thought he had discovered what mineralogists have been so long looking for, the native place of the diamond. In a rock with which diamonds were associated, he observed under the microscope what he took to be diamonds. The observation was apparently confirmed by other microscopists; but another, more acute or more fortunate, was able to see that the supposed gems were merely minute cavities, once occupied by crystals but now empty, the original tenants and formers of the faceted spaces having been dissolved and washed away.

Shall we say that the eyes of the mistaken microscopists deceived them? Not at all. They saw truly all that was to be seen, a certain play of light. They inferred that it was caused by tiny diamonds, and erred, not knowing or forgetting that there were other ways in which such appearances could be produced.

Take a still more plausible instance of reputed sense deception. Cross the second finger over the forefinger and roll a small object in the angle between their tips. The object will seem to be double. Touch gives a false report, it is said. We say: No; it simply reports the contact of some objects with the inside of one finger and the outside of the other, a sensation commonly produced by two objects separated by the breadth of the fingers. After a little practice with the crossed fingers, we cease to make the wrong interpretation of their report, just as we have all learned to do in the case of thumb and finger. So familiar are we with the touch of objects indifferently between either side of the thumb and either side of the several fingers that we never mistake their combined report. The same is true with regard to our two hands; from long experience we instinctively combine the double sensation they give into a single perception. Not so, however, with hands and feet—at least among a boot-wearing people. We are not used to feeling objects with our fingers and toes together; consequently when an object is touched, say by the great toe and the forefinger, the double sensation gives a double perception, though the object be single. Very probably the education of savages is more complete than ours in that respect. Shall we say their senses are therefore more trustworthy?

Against the view we have illustrated so fully, several correspondents have taken exception. One says:

"Allow me to ask, is not our judgment the offspring of our senses? Yes; and the more acute the senses, and the more harmony there is in their working together, the more accurate the judgment. Blot out of existence the five senses, and you blot out the judgment which you make lie back of them, and seem to make independent of them."

To this we need only reply that the fullest dependence, not only of judgment, but of all the faculties of the mind, upon the senses, may be admitted, as far as their development is concerned, without affecting our position. Whatever their organic connection, perception and inference are distinct operations; and no theory of mental action can make a delusion of sense out of an error in judgment.

Our correspondent proceeds to describe the nervous connection of the several organs of sense with the brain, and organs that the senses cannot be trusted because the nerve connection may be deranged or destroyed, and a correct report of the sense's action prevented: a contingency carefully ruled out of the discussion by our specification of health as a condition of right action on the part of the senses. This is not so bad, however, as the course of another who pronounces our position absurd and foolish, and, in proof of his assertion that "everything goes to prove the trustworthiness of the senses," gives a series of examples, all but one of which belong to the domain not of sense but of sensibility; for example: that one man delights in the odor of roses while to another it is indifferent; that one man enjoys the tumult and clamor of a battle, another abhors it, another cannot bear it; that one man likes tobacco, which to another is disgusting. The single exception was this: that a distant church spire looked to him not more that a foot long; therefore his sense of sight was not to be trusted!

It is surprising how common is this twofold error, to suppose it a function of the eye to see size, and to accuse the eye of inefficiency or dishonesty because the apparent size of objects is variable. Our first-mentioned correspondent has in this connection a theory that is quite new to us. "I have said," he remarks, "that the organs of sense have brain nerves; I not only believe this, but I believe that they each have more than one brain nerve. The eye, for instance, has a brain nerve which enables the mind to recognize form, another which enables it to recognize color, another which enables it to recognize size, etc. And upon the acuteness of these nerves depends the power of mind to recognize the different qualities reflected through the eye."

The theory is simply enough, but unfortunately it is not supported by anatomy and is flatly contradicted by experience; particularly the experience of those persons who have taught us most with regard to what we see and how we learn to see it—men and women born blind with cataract or some other curable organic defect, and enabled to see in later life by a surgical operation. To speak mildly, it is hardly just to impose upon the eye so many functions which do not belong to it, and then hold it guilty of breach of trust because it does not perform them satisfactorily.

This brings us by a roundabout way to our original enquiry: What do we really see?

We use our eyes in determining the size, solidity, distance, and motion of objects. Can we say absolutely that we see them? We frequently pronounce an object hard or soft, hot or cold, at sight. Do we see hardness or heat? From varied experience we have learned to associate different degrees of density and temperature in many objects with certain visual aspects of those objects; these perceived, we infer the softness or hardness, the warmth or cold; and so closely united are the perception and inference that we are apt to say we see what we really infer.

In like manner we infer or estimate size, distance, solidity, speed of motion, and the rest. In all such cases, then, an act of judgment involves many elements, sight being supplemented by extravisual processes, the mastery of which was slowly gained in infancy, but so thoroughly gained that they now seem automatic. In reality we see only light in its various hues and shades; but whether the source of the light is near or far, solid or superficial, it is no business of the eye, primarily, to determine. Consequently, when we mistake a painted object on a flat surface for a solid object in open space, when we think a sheet of water is ten miles across one day and only three miles the next, when a hawk speeding through space seems motionless, when a pool of water is mistaken for a damp flagstone by gas light, in the infinite instances when things are not what they seem and the eye is charged with treachery, that useful organ is simply wrongly accused. Its duty is correctly done; but through inattention, haste, or ignorance, we misinterpret its report.

We are not asserting the perfection of the human eye as an optical instrument. It is far from perfect; but the untrustworthiness with which it is charged does not arise from its optical imperfection: so, in almost every instance, in the case of the other senses. If we are deceived by them, it is our fault, not theirs.

But it may be asked, what difference does it make whether we regard the senses or what lies back of them as a source of error, so long as liability to mistake is admitted?

This very great difference: The one view logically leads to the brooding apathy of the Indian mystic, the other to the questioning, testing creative activity of modern thought. To surrender ourselves to the belief that error is our normal condition is to lose our grip of reality and drift into dreamy speculation. Believing the senses honest and truth-telling, we must regard error as an evil to be corrected by caution, culture, and widening knowledge; where they fail through dullness or narrowness of range, we can strengthen and verify them by mechanical devices. Distrust them utterly, and hope is lost; trust them, and we may pursue our course with something of the confidence of the passengers of the Prairie Belle, with Jim Bludsoe at the wheel, when

> "They all had faith in his cussedness
> And knowed he would keep his word!"

THE CAUSE OF PROFUSE RAINS.

Every one knows that the heat of the sun raises water from the earth in the form of vapor, which becomes clouds, that float around, and at last discharge the water of which they consist; this simply is the cause of rain. But we ask the reader if he has ever considered that the amount of water evaporated by the sun depends on the latter's heat? If this were increased, more water would evaporate and more come down; and if it were diminished, less would evaporate and less would come down, and the amount of rain would diminish, as it is certain that the water which comes down as rain must have been previously raised by the heat of the sun; as the sun is sometimes obscured by spots, it must be supposed to give less heat, and therefore cannot raise so much water as vapor: and under these circumstances the sun cannot properly be the cause of extraordinarily heavy rains and inundations. This is the theory advocated in some quarters, but it cannot stand the scrutiny of reason.

Measurements show that the heat emitted by the sun is not regulated by the spots; while at the same time that spots appear, the faculæ, giving more heat, also make their appearance, and go far to compensate for the diminution of heat caused by the spots, so that the total heat emitted by the orb is, for all practical purposes, a tolerably constant quantity; and it must be remembered that the evaporation chiefly takes place from the surface of the ocean, which covers three fourths of the earth's surface. Three fourths of this evaporated water falls back into the ocean, and one fourth on the land, or perhaps a little more, as clouds appear to be attracted by mountains, and by preference discharge their contents on land; but in any case the ocean receives back, in the form of rain, more than half the water evaporated from the surface. The circumstances attending the condensation of the cloud vapors into rain are very complex; and this operation is subject to so many various conflicting influences that a regular distribution of rain would be a matter of surprise, if not a total impossibility, and therefore we see the greatest irregularity in the rainfall prevail. In some limited regions of the earth, however, there exists a regularity in this regard; but this is simply caused by the more uniform circumstances in which such exceptional localities are placed; and the causes of this regularity may be, and have been, clearly traced by those who make the investigation of this subject a special pursuit.

If the total amount of evaporation, over the whole surface of the earth, be a nearly constant quantity, the total amount of rain falling over its whole surface must also be regular, because what goes up must come down; and if we had rain gages distributed over the whole earth and ocean surface, this proposition would, no doubt, be verified. But, by the irregular distribution of rainfall, some localities may be liberally supplied at the expense of others; or at some periods of time, the rainfall may become concentrated into shorter periods. If, then, such larger rainfalls take place within the limits of the valleys which supply our rivers, an inundation is the consequence. It may be that the amount of rainfall in some inundated districts is not greater for the whole season than is usually the case, or, if it is, the rainfall of other localities, or on the ocean, may have been so much less; so that, in order to account for an inundation or a great rainfall, it is not necessary to suppose the total amount of water falling has been greater than usual.

These considerations show how unnecessary it is to look for cosmic causes in explanation of such comparatively trifling meteorological phenomena as an extra rainfall in some districts. Some philosophers have even gone so far as to attribute it to the jets of incandescent hydrogen, ejected in the form of protuberances (during solar storms) from the sun's surface to a hight of a hundred thousand miles toward the earth, which, cooling while approaching our atmosphere, form water. If we consider that, at a distance of three million miles from the sun, the gravity towards that body is nearly as great as is the gravity on the surface of the earth towards the earth, it is clear that this solar hydrogen has little chance to reach us. If it did, and if it combined with our atmosphere's oxygen to form water, a terrible fate would be in store for the earth; because, if all the oxygen in our atmosphere were exhausted to combine with hydrogen to form water, it would only form water enough to raise the surface of the ocean six feet, as is easily proved by calculation.

STEEL BRONZE AN AMERICAN INVENTION.

We recently described the so-called steel bronze, which, as material for ordnance, is at the present time being widely discussed by European military people. It is an ordinary bronze of 90 parts copper and 10 of tin, of which the gun is cast on a copper core of less diameter than the bore. The