

filled. Among the minor University appointments during the past year were the following: Mr. Shaw, Emmanuel, Assistant Director of the Cavendish Laboratory; Mr. H. W. Pearson, Christ's, Assistant Curator of the Herbarium. To University lectureships—Mathematics, Mr. Love, St. John's; Midwifery, Mr. Stabb, Downing. The following have been appointed demonstrators: Mechanism and Applied Mechanics, Mr. Peace, Emmanuel; Animal Morphology, Mr. J. G. Kerr, Christ's; Botany, Mr. R. H. Biffin, Gonville and Caius; Pathology, Mr. T. Strangeways Pigg; teacher in Anthropology, Mr. Duckworth, Jesus.

THE chair in the medical department of the University of Pennsylvania, vacant by the death of Dr. William Pepper, will not be filled at present, it being recommended by the faculty that, for the present, Dr. James Tyson, professor of clinical medicine, be given full and general direction of the department of medicine, and that four assistants, Dr. John H. Musser, assistant professor of clinical medicine, Dr. Alfred Stengel, Dr. M. Howard Fussell and Dr. Frederick A. Packard, instructors in clinical medicine, be appointed to deliver, under Dr. Tyson's supervision, didactic lectures on medicine.

MISS AGNES M. CLAYPOLE, PH.B., Buchtel College and M. S., Cornell University, has been appointed assistant in microscopy, histology and embryology at Cornell University.

SECRETARY LONG has directed that the course in naval architecture begun at the Naval Academy at Annapolis last year under the now famous Constructor Hobson be transferred to the Massachusetts Institute of Technology. The course will cover a period of three years, including practical instruction in the summer in ship yards and navy-yards. Eight cadets will be detailed to take the course.

MR. FRANK IRVING SHEPHERD, recently acting professor of chemistry and physics in the University of Denver, has been appointed instructor in chemistry in the University of Cincinnati; and Dr. Thomas Evans, formerly instructor in organic chemistry at the Massachusetts Institute of Technology, and more recently chief chemist of the Proctor & Gamble Soap Company and of the American Cotton Oil Com-

pany, has been appointed instructor in technical chemistry at the University of Cincinnati.

PROFESSOR HOFER, of the University at Munich, has been appointed professor of geography in the University at Würzburg. Dr. Loewenherz has been qualified as docent in physics in the University at Königsberg.

DISCUSSION AND CORRESPONDENCE.

THE WINDMILL ILLUSION.

IN the issue of SCIENCE for September 16th Dr. F. C. Kenyon calls attention to the optical illusion to be seen when viewing a rotating electric fan, and requests some explanation of the same. The illusion consists in the apparently capacious reversal of the direction of rotation, and in a corresponding change of the plane of rotation.

This phenomenon has long been known to those who have investigated illusions of motion. So far as the writer's knowledge goes, it was first mentioned in literature in 1860, by the German Sinstedden.* Since that time frequent mention has been made of it and several explanations have been propounded. The essentials of the illusion can be seen in the case of windmills, electric fans, rotating bars, or rotating disks bearing heavy radial strips of black. For all of these the name of 'The Windmill Illusion' is currently employed.

The explanation of the illusion is obviously to be sought in the interpretation of equivocal factors entering into the total experience known as the perception of rotation. Sinstedden, and Helmholtz after him, tried to explain the matter along this line. That *eye-movements* do not enter in has been shown by experiments reported by Dr. Nichols at the first meeting of the American Psychological Association. The essence of the explanation lies in the consideration that the perception of rotation often rests upon the perception of distinct positions of the rotating body, and that the succession of these various positions or phases of rotation admits of either of two interpretations as regards the direction of rotation. That we do perceive motion by means of its phases may be readily demonstrated by rotating a disk bearing variously colored sectors in a dark

* Poggendorff's *Annalen*, CXI., 336.

room, the illumination being furnished by the electric spark. The rotation of the disk will seem to be now in one direction, now in the other, according as any sector, made visible by the instantaneous flash, is seen to occupy a position on this or that side of the sector seen just previously. If in addition any perceived phase could admit of a double interpretation we should have the illusion in question.

The reason for the illusion may, perhaps, be seen in this way. Fancy, for example, a narrow pennant floating from a staff, the observer being so placed that the line of direction of the pennant shall make an angle of, say, 30° with the plane passing through the observer and the staff. Further, let the pennant droop somewhat from the horizontal. If, now, this be viewed from a sufficient distance and by a somewhat dim light, it will prove impossible to determine absolutely whether the pennant is floating towards or away from the observer. That is, we have here a simple case of equivocal interpretation. The same double interpretation is true for every pair of positions between those just considered and the point where the pennant is perpendicular to the plane above mentioned. Suppose now that the pennant be made to rotate about the staff, occupying successively each of these positions. Manifestly the direction of rotation can not now be determined with full satisfaction, for since each of the phases seen was capable of a double interpretation, their succession must give rise to a possible perception of rotation in either of two directions, either from a position more remote to one nearer, or *vice versa*. Probably one direction will always be selected as *real* over against the other as illusory, for there are usually some subordinate factors that are dimly perceived which admit of only a single meaning.

Here then we have a type of the illusion. Now let the pennant be replaced by the vanes of a windmill or by the blades of an electric fan, and we find further equivocal factors present. Take the latter case. Not only the direction of the rotation, but the *slope of the blades* as well may be perceived in two ways. For the patches of light and shade, on the basis of which the slope is perceived, are also equivocal, and the particular illusory perception that we

get, not only of the *direction*, but also of the *plane* of the rotation, depends upon the special combination of these two equivocal factors. The whole matter is then at bottom one of the perspective interpretation of successive perceptions of light and color in their various combinations.

The above explanation is strongly substantiated by the universally observed fact that the rotating object must be viewed at a certain distance or by a dim light. That is, certain details which admit of but one meaning must be suppressed before the illusion can arise. Again, the fact that the illusion is at its best when the rotating object is viewed very *obliquely* makes for the explanation given. For here perspective interpretation is given full play. This oblique position of the observer is, however, not necessary in every case, for the writer has repeatedly seen the illusion when viewing a four-vaned windmill directly *en face*. Further, this explanation is strengthened by the fact that the illusion is most clear when one eye is covered.

Which one of the rotations shall in any given case be seen, when either is equally possible, will depend probably upon the position of the eyes. This is influential in all equivocal perceptions, and, as Wundt has pointed out, the law seems to be that the point fixated appears nearest to the observer.

Attention may be called here to a somewhat similar illusion mentioned by Silvanus P. Thompson in the *Quarterly Journal of Science* for 1879. If a crow be seen at dusk flying low against the sky the wings, seen alternately above and below, give the appearance of a single wing rotating about the crow's body like the blade of a screw propeller about its axis. The points of similarity between this and the Windmill Illusion are manifest.

A. H. PIERCE.

AMHERST COLLEGE.

MR. KENYON'S optical illusion described in your issue of September 16th may be best explained by another illusion with which I have been long familiar.

Take an ordinary glass goblet, tilt it a little from you, so that the farther rim is seen

through the glass. Shut one eye so as to get rid of binocular perspective.

You can now at will change the relative position of the two parts of the rim. At one moment you see the farther rim through the glass in its true position; at another it seems the nearer of the two and you seem to be looking into the mouth of the goblet.

Now, if the glass were rotating, it is evident that it would seem to rotate in the one direction or the other, according as we imagined the real or the reversed position of the rims.

The phenomena can be seen with both eyes open, but is clearer with one eye shut for the reason already given.

Now, I think the phenomenon of the rotating fan is explained in a similar way. The observer, I suppose, looked at the fan from a little *below* the horizontal, but seemed to be looking at it from *above*, when the rotation was apparently reversed.

JOSEPH LECONTE.

BERKELEY, CAL., September 24, 1898.

[A similar explanation has been sent us by Mr. Garrett P. Serviss, Jr. It is the explanation of Sinsteden, who first described the phenomenon in 1860, as stated above by Mr. Pierce. Cf. von Helmholtz, *Physiol. Optik.*, 1895, p. 770.—ED. SCIENCE.]

SCIENTIFIC LITERATURE.

Memoirs from the Biological Laboratory of the Johns Hopkins University, IV., 1. *The Cubomedusæ*. A Dissertation presented for the Degree of Doctor of Philosophy, in the Johns Hopkins University, 1897. By FRANKLIN STORY CONANT. A Memorial Volume. Baltimore. 1898.

The late Dr. Conant, it will be recalled by many, was a member of the marine laboratory of the Johns Hopkins University, stationed during the summer of 1897 at Port Antonio, Jamaica. Toward the end of the season's work fever broke out. The director of the expedition, Dr. J. E. Humphrey, died in a sudden and alarming manner. Dr. Conant assumed charge of the laboratory, and, though aware of his own great danger, remained in Port Antonio, devoting himself to the service of others who needed his help. This generous subordination

of self cost him his life, for he contracted the fever, and, though able to reach this country, he died a few days after his arrival in Boston.

Dr. Conant's many friends, well aware of his candid, judicial mind, his keenness and persistency in observing and in reasoning from observations to a conclusion, have entertained the highest expectations of the work he was to do in science. Cut off at the beginning of his career, he leaves behind him several smaller papers and the dissertation before us. On closing this volume the author's friends will feel confirmed in their high opinion of his abilities, and those who did not know Dr. Conant will realize with regret that an able and conscientious naturalist has been removed from our midst.

Dr. Conant's dissertation, published as a memorial volume by his friends, fellow students and instructors, with the aid of the university in which he had recently taken his doctor's degree, deals with the anatomy and classification of one of the most interesting groups of jelly-fish, the Cubomedusæ. In this group, embracing but a small number of species, the scyphomedusan structure, with which most of us are chiefly familiar through the study of *Aurelia*, *Cyanea* or *Dactylometra*, is in general presented as destitute of the complications which characterize the more common forms. This simplicity in general structure places the group close to the stem-forms, *Tessera* and *Lucernaria*, themselves scarcely more than sexually ripe *Scyphistomas*, and makes a comparison with existing Actinozoa an easy matter. Curiously enough, the members of this primitive group possess the most highly developed sense-organs as yet described among coelenterates, the nervous system being correspondingly differentiated. In one other respect the Cubomedusæ are unique, in that they alone among the Scyphomedusæ possess a velum. The phylogenetic origin of this velum (velarium) has been the subject of some discussion, the balance of opinion inclining to the belief that it has arisen through the fusion of marginal lobes similar to those found in the Peromedusæ and the Ephyropsidæ (*Nausithoe*), and is merely analogous to, not homologous with, the velum of the Hydromedusæ. That this is the case is borne out by the presence in the velum of gastrovascular diverticula. This