

Observatory party, which is to occupy a station in Chili, but Prof. W. H. Pickering writes that difficulties of transport will prevent him from taking the 20-inch mirror he has at Arequipa to the Harvard station; and owing to this and to the already large programme of the English party in Africa there is some doubt whether they will take one of the mirrors. April being the middle of the rainy season in Brazil, it is not deemed advisable to send one of the mirrors to that station.

The duration of totality at Para Cura is four minutes forty-four seconds, the altitude of the sun being between  $70^{\circ}$  and  $80^{\circ}$ . At Fundium the totality lasts four minutes eight seconds, the altitude of the sun being about  $54^{\circ}$ .

The Joint Eclipse Committee having arranged the expeditions and the general scheme of work, final details as to the actual operations have been left to a sub-committee consisting of the Astronomer Royal, Captain Abney, Mr. H. H. Turner, Prof. Thorpe, Mr. A. Taylor, and the secretary, Dr. Common. Prof. Lockyer, previous to leaving England for Egypt, determined the exposures to be given by Messrs. Fowler and Shackleton with the integrating spectroscopes. These, with the final instructions to observers drafted by the sub-committee, will be published in due course.

At present very few details are available as to the actual work to be undertaken by foreign observers. The Harvard College Observatory expedition to Chili has already been mentioned. Prof. Schaeberle, of the Lick Observatory, has already started for Chili, and will use a six-and-a-half-inch equatorial, a five-inch horizontal photoheliograph of forty-feet focus, and a Dallmeyer portrait lens. He will be assisted by Mr. Gale, an amateur, from Paddington, N.S.W. A Chilian party will also observe the eclipse in Chili.

At Para Cura there will probably be two or three American parties, one being announced as probably under Prof. H. S. Pritchett, from Washington University, St. Louis, and another will probably be brought to that station by Prof. David P. Todd. A Brazilian party will also observe. The Bureau des Longitudes, Paris, are sending a complete expedition to Joal, in Africa, under MM. Deslandres and Bigourdan, the latter observer having already started for his station. The work undertaken will be to obtain photographs of the corona and of its spectrum. M. de la Baume Pluvinel will also go to Joal to photograph the corona. At present we have not heard of any Italian expedition, but it is hoped that Prof. Tacchini will be able to arrange to observe the eclipse.

A. TAYLOR.

#### MEASURE OF THE IMAGINATION.<sup>1</sup>

THE first perceptible sensation is seldom due to a solitary stimulus. Internal causes of stimulation are in continual activity, whose effects are usually too faint to be perceived by themselves, but they may combine with minute external stimuli, and so produce a sensation which neither of them could have done singly. I desire now to draw attention to another concurring cause which has hitherto been unduly overlooked, or only partially allowed for under the titles of expectation and attention. I mean the Imagination, believing that it should be frankly recognised as a frequent factor in the production of a just perceptible sensation. Let us reflect for a moment on the frequency with which the imagination produces effects that actually overpass the threshold of consciousness, and give rise to what is indistinguishable from, and mistaken for a real sensation. Every one has observed instances of it in his own person

<sup>1</sup> Extract from a lecture on "The Just-Perceptible Difference," delivered before the Royal Institution, on Friday, January 27, by Francis Galton, F.R.S. We hope to give next week an extract on "Optical Continuity."

and in those of others. Illustrations are almost needless; I may, however, mention one as a reminder; it was current in my boyhood, and the incident probably took place not many yards from where I now stand. Sir Humphrey Davy had recently discovered the metal potassium, and showed specimens of it to the greedy gaze of a philosophical friend as it lay immersed in a dish of alcohol to shield it from the air, explaining its chemical claim to be considered a metal. All the known metals at that time were of such high specific gravity that weight was commonly considered to be a peculiar characteristic of metals; potassium, however, is lighter than water. The philosopher not being aware of this, but convinced as to its metallic nature by the reasoning of Sir Humphrey, fished a piece out of the alcohol, and, weighing it a while between his finger and thumb, said seriously, as in further confirmation, "How heavy it is!"

In childhood the imagination is peculiarly vivid and notoriously leads to mistakes, but the discipline of after life is steadily directed to checking its vagaries and to establishing a clear distinction between fancy and fact. Nevertheless, the force of the imagination may endure with extraordinary power and be cherished by persons of poetic temperament, on which point the experiences of our two latest Poet-Laureats, Wordsworth and Tennyson, is extremely instructive. Wordsworth's famous "Ode to Immortality" contains three lines which long puzzled his readers. They occur after his grand description of the glorious imagery of childhood, and the "perpetual benediction" of its memories, when he suddenly breaks off into—

"Not for these I raise  
The song of thanks and praise,  
But for those obstinate questionings  
Of sense and outward things,  
Fallings, from us, vanishings," &c.

Why, it was asked, should any sane person be "obstinately" disposed to question the testimony of his senses, and be peculiarly thankful that he had the power to do so? What was meant by the "fallings off and vanishings," for which he raises his "song of thanks and praise"? The explanation is now to be found in a note by Wordsworth himself, prefixed to the ode in Knight's edition. Wordsworth there writes—"I was often unable to think of external things as having external existence, and I communed with all I saw as something not apart from, but inherent in, my own immaterial nature. Many times while going to school have I grasped at a wall or tree to recal myself from this abyss of idealism to the reality. At that time I was afraid of such processes. In later times I have deplored, as we all have reason to do, a subjugation of an opposite character, and have rejoiced over the remembrances, as is expressed in the lines 'Obstinate questionings,' &c." He then gives those I have just quoted.

It is a remarkable coincidence that a closely similar idea is found in the verses of the successor of Wordsworth, namely, the great poet whose recent loss is mourned by all English-speaking nations, and that a closely similar explanation exists with respect to them. For in Lord Tennyson's "Holy Grail" the aged Sir Percivale, then a monk, recounts to a brother monk the following words of King Arthur:—

"Let visions of the night or of the day  
Come, as they will; and many a time they come  
Until this earth he walks on seems not earth,  
This light that strikes his eyeball is not light,  
The air that smites his forehead is not air,  
But vision," &c.

Sir Percivale concludes just as Wordsworth's admirers formerly had done: "I knew not all he meant."  
Now, in the *Nineteenth Century* of the present month

<sup>1</sup> Knight's edition of Wordsworth, vol. iv. p. 47.

Mr. Knowles, in his article entitled "Aspects of Tennyson," mentions a conversational incident curiously parallel to Wordsworth's own remarks about himself:—"He [Tennyson] said to me one day, 'Sometimes as I sit alone in this great room I get carried away, out of sense and body, and rapt into mere existence, till the accidental touch or movement of one of my own fingers is like a great shock and blow, and brings the body back with a terrible start.'"

Considering how often the imagination is sufficiently intense to stimulate a real sensation, a vastly greater number of cases must exist in which it excites the physiological centres in too feeble a degree for their response to reach to the level of consciousness. So that if the imagination has been anyhow set into motion, it shall as a rule originate what may be termed *incomplete* sensations, and whenever one of these concurs with a real sensation of the same kind, it would swell its volume.

This supposition admits of being submitted to experiment by comparing the amount of stimulus required to produce a just perceptible sensation, under the two conditions of the imagination being either excited or passive.

Several conditions have to be observed in designing suitable experiments. The imagined sensation and the real sensation must be of the same quality; an expected scream and an actual groan could not reinforce one another. Again, the place where the image is localised in the theatre of the imagination must be the same as it is in the real sensation. This condition requires to be more carefully attended to in respect to the visual imagination than to that of the other senses, because the theatre of the visual imagination is described by most persons, though not by all, as internal, whereas the theatre of actual vision is external. The important part played by points of reference in visual illusions is to be explained by the aid they afford in compelling the imaginary figures to externalise themselves, superimposing them on fragments of a reality. The visualisation and the actual vision fuse together in some parts, and supplement each other elsewhere.

The theatre of audition is by no means so purely external as that of sight. Certain persuasive tones of voice sink deeply, as it were, into the mind, and even simulate our own original sentiments. The power of localising external sounds, which is almost absent in those who are deaf with one ear, is very imperfect generally, otherwise the illusions of the ventriloquist would be impossible. There was an account in the newspapers a few weeks ago of an Austrian lady of rank who purchased a parrot at a high price, as being able to repeat the Paternoster in seven different languages. She took the bird home, but it was mute. At last it was discovered that the apparent performances of the parrot had been due to the ventriloquism of the dealer. An analogous trick upon the sight could not be performed by a conjuror. Thus he could never make his audience believe that the floor of the room was the ceiling.

As regards the other senses the theatre of the imagination coincides fairly well with that of the sensations. It is so with taste and smell, also with touch, in so far that an imagined impression or pain is always located in some particular part of the body, then if it be localised in the same place as a real pain, it must coalesce with it.

Finally, it is of high importance to success in experiments on Imagination that the object and its associated imagery should be so habitually connected that a critical attitude of the mind shall not easily separate them. Suppose an apparatus arranged to associate the waxing and waning of a light with the rising and falling of a sound, holding means in reserve for privately modifying the illumination at the will of the experimenter, in order that the waxing and waning may be lessened, abolished, or even reversed. It is quite possible that a person who had no idea of the purport of the experiment might be deceived, and be led

by his imagination to declare that the light still waxed and waned in unison with the sound after its ups and downs had been reduced to zero. But if the subject of the experiment suspected its object he would be thrown into a critical mood; his mind would stiffen itself, as it were, and he will be difficult to deceive.

Having made these preliminary remarks, I will mention one only of some experiments I have made and am making from time to time, to measure the force of my own imagination. It happens that although most persons train themselves from childhood upwards to distinguish imagination from fact, there is at least one instance in which we do the exact reverse, namely, in respect to the auditory presentation of the words that are perused by the eye. It would be otherwise impossible to realise the sonorous flow of the passages, whether in prose or poetry, that are read only with the eyes. We all of us value and cultivate this form of auditory imagination, and it commonly grows into a well-developed faculty. I infer that when we are listening to the words of a reader while our eyes are simultaneously perusing a copy of the book from which he is reading, that the effects of the auditory imagination concur with the actual sound, and produce a stronger impression than the latter alone would be able to make.

I have very frequently experimented on myself with success, with the view of analysing this concurrent impression into its constituents, being aided thereto by two helpful conditions, the one is a degree of deafness which prevents me when sitting on a seat in the middle rows from following memoirs that are read in tones suitable to the audience at large; and the other is the accident of belonging to societies in which unrevised copies of the memoirs, that are about to be read, and usually in monotones, are obtainable, in order to be perused simultaneously by the eye. Now it sometimes happens that portions of these papers, however valuable they may be in themselves, do not interest me, in which case it has been a never-flagging source of diversion to compare my capabilities of following the reader when I am using my eyes, and when I am not. The result depends somewhat on the quality of the voice; if it is a familiar tone I can imagine what is coming much more accurately than otherwise. It depends much on the phraseology, familiar words being vividly represented. Something also depends on the mood at the time, for imagination is powerfully affected by all forms of emotion. The result is that I frequently find myself in a position in which I hear every word distinctly so long as they accord with those I am perusing, but whenever a word is changed, although the change is perceived, the new word is not recognised. Then, should I raise my eyes from the copy, nothing whatever of the reading can be understood, the overtones by which words are distinguished being too faint to be heard. As a rule, I estimate that I have to approach the reader by about a quarter of the previous distance, before I can distinguish his words by the ear alone. Accepting this rough estimate for the purposes of present calculation, it follows that the potency of my hearing alone is to that of my hearing *plus* imagination, as the loudness of the same overtones heard at 3 and at 4 units of distance respectively; that is as about  $3^2$  to  $4^3$ , or as 9 to 64. Consequently the potency of my auditory imagination is to that of a just perceptible sound as 16-9, or as 7 units, to 16. So the effect of the imagination in this case reaches nearly half-way to the level of consciousness. If it were a little more than twice as strong it would be able by itself to produce an effect indistinguishable from a real sound.

Two copies of the same newspaper afford easily accessible materials for making this experiment, a few words having been altered here and there in the copy to be read from.

I will conclude this portion of my remarks by suggesting that some of my audience should repeat these experiments on themselves. If they do so, I should be grateful if they would communicate to me their results.

*PROTOCERAS, THE NEW ARTIODACTYLE.*

LAST year the American Museum of Natural History established a department of mammalian palæontology for the purpose of securing and exhibiting collections from all the tertiary horizons of the west. Dr. J. L. Wortman, well known by his discoveries while associated with Prof. Cope, was put at the head of the field work, and under his direction explorations have already been made in the Laramie or Upper Cretaceous, and in three of the great divisions of the tertiary, namely, the Wasatch, the Puerco, and the Lower Miocene or White River.

The discovery of the first example of *Palæonictis* found in America was mentioned in NATURE last year. From the Puerco are brought remains of about 400 individuals, adding many new facts to the discoveries of Prof. Cope. From the Laramie are 400 of the small isolated teeth of the kind recently described by Prof. Marsh. These are found by the writer to have a distinctly tertiary rather than mesozoic character, and while intermediate between the mesozoic and Puerco species, they decidedly resemble the latter. *Meniscoëssus*, for example, about which there has been so much discussion, proves to be a plagiulacid,

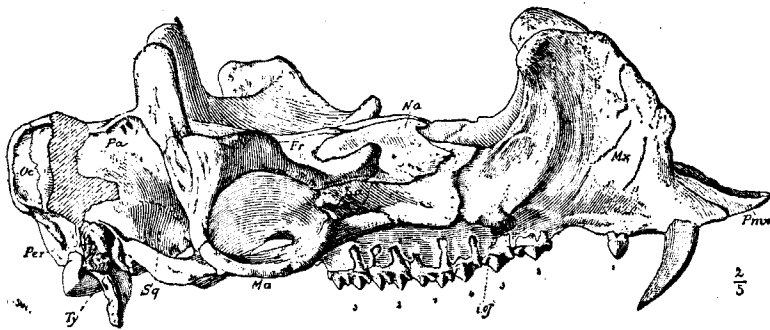


FIG. 1.—Side view of skull.

and also an ancestor of *Polymastodon*, which is thus shown to be a huge *Plagiulax*, in which the fourth cutting premolar is reduced.

By far the most perfect specimens have, however, been brought from the Lower Miocene; and here it appears that practically a new horizon has been developed, for the collection is full of fresh forms. Many of these are new species intermediate between the true White River or *Titanotherium* fauna, and the Middle Miocene, but others are new genera, and represent distinct unrelated forms.

In this Lower Miocene collection are included portions of six skulls and the fore and hind feet of an Artiodactyle, of about the size of a sheep. The most complete skull is here figured exactly as found, and is seen at once to depart from all known Artiodactyles in many important characters. There are no less than four protuberances upon each side of the skull. Hindmost are two processes upon the parietals, which are placed upon the superciliary ridges as they diverge from the sagittal crest. These processes are close together and oval in section, reminding us of the posterior pair of horns in *Vintatherium* rather than of the conical or rounded horns found in the giraffes and some other Artiodactyles. Their position upon the parietal bones is also peculiar. The superciliary ridges extend outwards into two widely projecting plates of bone, which curve upwards above the orbits; these plates are

upon the frontals, and the frontals also bear a pair of small conical processes just behind their junction with the nasals. But even more exceptional than these parietal and frontal processes are the great vertical plates rising from the maxillaries, slightly recurved, and reaching the full height of the parietal protuberances. Seen from above, these plates are found to be not in contact, but to enclose a long deep cleft, representing the anterior narial opening. This is bridged over posteriorly by the nasals, which, as shown in the second figure, are extremely abbreviated. Correlated with the development of these processes are a number of strong ridges, which form supporting buttresses for the horns. These extend, as above described, from the sagittal crest outwards, also from the anterior margin of the orbit forwards. This lateral maxillary ridge, as it may be called, terminates in a process just above the infraorbital foramen; and this process, although small, seems to illustrate the remarkable tendency of this little skull to develop osseous projections at every avail-

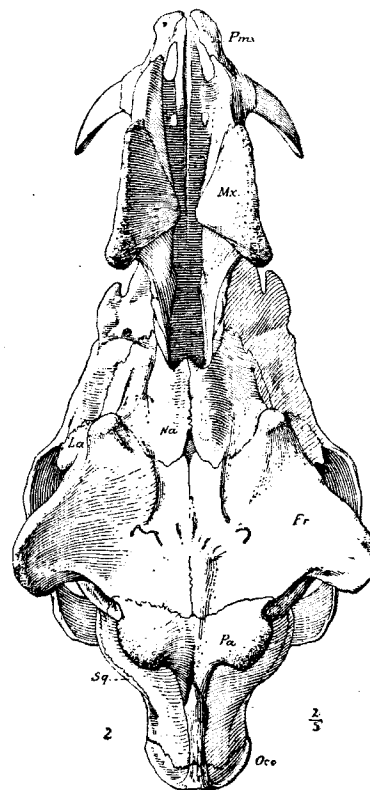


FIG. 2.—Top view of skull.

able point. The character of these projections is different from that found elsewhere among the Artiodactyla; they are not horn-cores, neither are they similar to the processes upon the parietals of the giraffe. The development of these multiple bony protuberances suggests the skulls of *Sivatherium*, *Tetraceros*, and other eastern ruminants; but the proportions of the skull are wholly different. The olfactory chamber, which is usually so expanded in the Artiodactyla, is here extremely reduced; the nasals barely reach beyond the middle line of the skull.

Up to this point the study of the skull appeared to present an entirely new form, but later the other skulls were removed from the matrix, and among them one was found with small canine teeth, entirely lacking all the processes upon the frontals, and giving indications that those upon the maxillaries were either absent or comparatively small. The parietals were unfortunately missing, but the idea at once suggested itself that this might be a female skull. Two years ago Prof.