

marvel because of the great pyramids, and they have always been considered one of the wonders of the world; but, reckoned at the present cost of masonry, a dozen such pyramids could be built for the expense involved in the Nicaragua Canal. And when it shall be built the engineer may well improve the great waterways of the interior and build fleets of steel barges that can withstand the sea, so that our products can be sent without transshipment from our inland cities to the western coasts of the Americas. Another product of the century of significant import is Portland cement. With the aid of the chemist this material has been so improved and made accessible that now the artificial stone made from it is most widely used and is superior to most natural ones. Furthermore there is the unequivocal indication that, in combination with the all-important steel, many classes of structures of superior characteristics will be designed. Already there have been built many steel and concrete bridges which are a hundred feet in span and more, and for the Memorial Bridge at Washington, maximum spans of this construction are planned to be 192 feet each in length; while the engineer who designed it considered perfectly practicable an alternative plan of similar arches 283 feet in length. Arches of such majestic span are among the imminent constructions of the engineer.

A half-century ago Macaulay said, "Those projects which abridge distance have done most for the civilization and happiness of our species." And yet, since then, transportation facilities have increased many-fold, the first ocean cable had not been laid, nor was the telephone in use, nor other distance-annihilating inventions made. The attainment of results both definite and valuable has been in constantly accelerating ratios through all the broad field of endeavor which marks the

domain of the engineer, viz., the 'direction of the great sources of power' and the development of the boundless resources of materials in nature to the use and convenience of mankind. The effect and value of this art pervade all lines of human interest and of contact, whether following Macaulay's idea of potentially bringing peoples nearer together or in the way (largely developed since his day) of rendering it possible to make life more thorough and intense by the concentration of power and of effort in great centers of activity, which is made possible by engineering structures and developments such as the towering office and industrial buildings of the last score of years; the tremendous concentrated power in steam and electric machinery of the present; the penetrating circulation of life-bringing, waste-removing water, ministering to our cities as does the blood to the body; and other examples of almost infinite variety which would cause amazement were they not so common now.

The glory and the power of the civilization of to-day result from the concentration of forces, both human and material, commanding the resourcefulness of mankind, applying the principles and discoveries of pure science, and developing the resources of nature for this purpose; and such is the degree of successful adaptation already reached, that the span of life of man potentially surpasses the millennial existences of legendary times. 'Better fifty years of Europe than a cycle of Cathay.' And the crowning glory of the measure of achievement thus far reached is that its inspiration is the welfare of the race.

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MONAURAL LOCALIZATION OF SOUND.

IN the *Psychological Review* for May, 1901, occurs a detailed account of an investiga-

tion conducted by Dr. Warner Fite and the present writer upon the capacities of auditory localization in a man totally deaf in one ear. The readers of *SCIENCE* may be interested in a brief statement of the essential facts observed.

The subject of the experiments is a man of thirty, who lost his hearing in one ear during early childhood, as the result of scarlet fever. The present symptoms, as reported by expert clinical test, indicate total nerve-deafness and consequently lesion of the labyrinth. The drum membrane was originally destroyed by ulceration of the middle ear and a scar has now replaced it. The precise condition of the bones of the middle ear cannot be determined. The malleus appears to be intact. The uninjured ear is decidedly more acute than the average, but in no such degree as would warrant the term hyperesthetic.

Without entering into details, the apparatus employed in the experiments may be described as consisting of a mechanical device, whereby noises and tones may be given in various directions and at a constant distance from the subject's ear. The arrangement permits the exact registration, in connection with the surface of an imaginary sphere, of each location from which a sound is given. The instrument permits all the adjustments to be made noiselessly, so that the subject, who keeps his eyes closed during the experimentation, receives no suggestion whatever of the direction from which the sound proceeds. The stimuli used consisted of tuning fork tones, the tones of a Galton whistle and the snapping sound made by sending an electric current through a telephone. The tones of the forks are practically pure. The notes of the whistle are more complex and the noise of the telephone is highly complex, containing a large number of partial tones.

It will facilitate a succinct statement of the results to imagine the subject seated in

the center of a large clock dial placed horizontally. The figure twelve is directly in front, the figure six behind, three is opposite the right ear and nine opposite the left ear, which is deaf. The sounds of which we shall speak first are given at the height of the ear.

Pure tones are almost, if not wholly, unlocalized by this subject. Often he can assign no position whatever to such tones, and, when he does hazard a location, the percentage and character of error show that the process is extremely inaccurate. On the other hand, complex sounds are localized with an accuracy which follows closely the number and audible nature of the partial tones they contain. The one exception to this is the region lying between eight and ten on the face of our illustrative dial. This is the region immediately opposite the deaf ear. To offset this defect the discrimination between positions immediately in front and those directly behind is superior to that of normal persons, for whom this distinction is notoriously uncertain. For the remaining regions, from ten toward the right around to eight, the localizations are only slightly inferior to those of normal individuals. Occasional confusions of the right and left hemispheres occur, which are almost unknown to binaural hearing. But in general, both as regards the character of the error and as regards the amount, the localizations are surprisingly like those of the binaural type.

In normal persons the localization of sounds is commonly supposed to depend upon the differences in the stimulations reaching the two ears. These differences are describable as partly differences in intensity and partly differences in quality. Thus, a sound opposite the right ear, for example, stimulates that ear more intensely than it does the left ear, and, if it be a complex sound, more of its component overtones will be noticeable to the right ear

than to the left, so that qualitatively it will be perceived as different from the same sound when heard directly in front. In the case of monaural hearing it is clear that the intensity of a sound can afford only the most ambiguous information. An apparent change in intensity in such a case may mean change of distance, change of direction, change of actual intensity or some combination of these alternatives. But the single ear is by no means so helpless as regards the detection of qualitative differences due to changes of direction. Our subject himself connected his capacity to localize sounds with this noticed change in quality. His results show that (although in every case he remained ignorant of his success or failure during the experimentation) he possessed to begin with a relatively accurate auditory orientation on the basis of these qualitative peculiarities of sounds due to their direction, and, furthermore, that after gaining a little familiarity with the sounds, his localizations became very accurate. Nor did he seem to find any serious difficulty in determining direction, when the absolute distance of the sounds was varied, nor yet when the absolute intensity was varied. Pure tones he could not localize for they undergo no qualitative modifications by change of direction. Intensity changes are the only ones of which they are susceptible. Slightly complex sounds he can localize fairly. Highly complex sounds, possessing component tones well inside the range of ready detection, he can localize extremely well, save in the region just opposite the deaf ear. The same statements hold for localizations above and below the equatorial plane, to which we have confined our description. The modifications met with outside this plane are all conformable to the fundamental theory of the dependence of the localizations upon qualitative differences in the sounds. The pinna, the meatus, the

bones of the head, etc., all contribute to the production of these qualitative modifications.

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FOOD OF SEA LIONS.

THE California State Board of Fish Commission during the past two years has taken steps to kill off a very large number of sea lions on the California coast, on the ground that these animals are highly destructive to the salmon fishery. The president of the board, Mr. Alexander T. Vogsang, claims that it is not the intention of the board to exterminate the sea lions, but merely to kill '10,000 of the 30,000 that now infest our harbor entrance and contiguous territory.*' The opinion of observers familiar with the sea lion rookeries is that the number of animals has been greatly exaggerated, and that long before Mr. Vogsang has killed the contemplated 10,000 there would not be a living sea lion left on the whole coast. Already many have been killed and, unless public sentiment is aroused to check the movement, some of the most interesting rookeries of the State are in danger of depletion. The Fish Commissioners have employed men to shoot the sea lions, and are loud in their lamentations because the Government light-house reservations have not been thrown open to the slaughter.

The local fishermen, the State Fish Commission and others assert without qualification that the sea lions feed extensively on salmon, and the inference from their statements is that the animals subsist chiefly, if not entirely, on fish. A few years ago, when similar complaints were made against the fur seals, I took the trouble to examine the stomach contents of a large number of these animals, and found to my surprise

* In letter to Hon. Lyman J. Gage, Secretary of the Treasury, dated San Francisco, June 3, 1899..