ON ALTERNATING SOUNDS.

BY DR. FRANZ BOAS.

Attention has been called recently to an interesting phenomenon, which, in a somewhat misleading way, has been termed "sound-blindness." It was observed that a considerable number of individuals cannot distinguish differences in key and timbre of sounds which are easily discerned by ordinary ears. The similarity of this phenomenon to color-blindness led to the adoption of the name of "sound-blindness." An exact analogue of color-blindness would, of course, be a case of lacking faculty to distinguish the key of sounds, but this, so far as the writer is aware, has never been observed. The characteristic feature of sound-blindness is inability to perceive the essential peculiarities of certain sounds.

Investigation of this subject has been carried on exclusively in regard to the phonology of languages, researches being made on the faculty of individuals to recognize certain consonants and vowels. It is well known that on hearing for the first time a word of which we do not know the derivation we are liable to misunderstand it. This fact may arise from two causes: The word may be so long that we are unable to grasp its phonetic components and their sequence at a single hearing, or we may fail to perceive the peculiar character of each phonetic element.

We have to consider here only the second case. Experiments on this subject have generally been made on children, as it is comparatively easy to find words unknown to them. Such words are dictated, the children try to render them by writing, and the misspelled words are studied. Recently Miss Sara E. Wiltse, at the instance of Prof. G. Stanley Hall, made a very interesting study of this phenomenon, the results of which have been published in the "American Journal of Psychology," i, p. 702. She discovered very soon that long words, as *ultramarine*, *altruistic*, *frustrate*, *ultimatum*, etc., gave unsatisfactory results, as the children failed to grasp the sequence of the component sounds. Next a series of monosyllabic words, suggested by Dr. Clarence J. Blake, was experimented with, which gave very interesting results. In the word *fan*, for instance, the *f* was

understood as *kl* once, *s* once, *th* surd three times, *th* sonant five times, the following words being substituted for fan: Clams (1), ram (1), fang (1), fell (2), fair (4), thank (3), than (5). As will be observed, no senseless combinations of sounds have been substituted for the dictated word, and a glance at Miss Wiltse's list shows that such is very rarely the case.

The results of these experiments are very satisfactory, notwithstanding the unphonetic character of English orthography. They show that sounds are not perceived by the hearer in the way in which they have been pronounced by the speaker.

Let us examine how this misunderstanding of sounds originates. We learn to pronounce the sounds of our language by long usage, and attain great facility in bringing our sound-producing organs into the positions in which these sounds are produced. We also learn by constant and long-continued practice to pronounce certain combinations of sounds. The character of such sounds depends solely upon the position of the sound-producing organs and the force with which the air passes out of the mouth or nose. Although we learn by practice to place our organs in certain positions, it will readily be understood that these positions will not be exactly the same every time we attempt to produce a certain sound, but that they will vary slightly. Preceding and succeeding sounds and many other circumstances will exert a certain influence upon the sound which we intend to produce.

The vibration of the air corresponding to this sound sets into motion the membrane of the tympanum of the hearer, who then perceives the sound. But how does he apperceive it? Only by means of similar sounds he has heard before. We have seen that the vibrations producing the percept vary slightly, about a certain average; besides this, we have to consider that the concept of a sound is still more variable.

It may be well to explain this more fully. If we have two resembling sensations separated by a considerable interval, the probability that we will believe them to be identical, although they are in fact different, will be the greater the more nearly similar both sensations, the longer the interval and the less the attention. For instance, if I am shown a bluish white first and a yellowish white a little later, the probability is that, on being asked, I shall declare both to be of the same color. To use the technical term, the difference between the two stimuli will be so small that it does not exceed the differen-

tial threshold. This phenomenon must be clearly distinguished from the differential threshold of two sensations that adjoin one another in space or time. In the latter case the inability to perceive the difference is due to physiological causes, at least to a great extent; it is due to a failure to perceive a phenomenon or a process. If, for instance, two spaces of greater and less intensity adjoin each other, we may be unable to discern the dividing line; if the intensity of a light be suddenly increased, we may fail to discover the change. In the former case, however, when both sensations are separated by an interval, a failure to distinguish both is mainly due to psychical causes.

The inability to distinguish sensations, even if adjoining one another in space or time, proves, however, that what we call one sensation corresponds to certain series of slightly different stimuli. Experiments show that the amplitude of this series is the larger the less the attention bestowed while the sensations were perceived.

On a former occasion the writer made a series of experiments in order to ascertain the influence of the interval between two sensations upon the amplitude of the series of stimuli which cause one sensation, or, as it is generally termed, upon the differential threshold, and it was found that, within certain limits, the amplitude increased rapidly. In other words, the longer the interval the more readily one stimulus is mistaken for another similar one, or the longer the interval the greater the probability that a stimulus considerably differing from the original one is mistaken for the same.

The same series of experiments showed the existence of an unexpectedly great influence of practice. Pairs of parallel horizontal lines, the upper 35 mm. long, the lower from 34 to 39 mm. long, were observed, and the judgment was formed as to which appeared longest. It very soon became evident that the combination 35, 37 mm. assumed the character of a standard, to which all others were compared. Next a similar series of experiments with pairs of lines about 25 mm. long was made, and then I proceeded to form estimates of the absolute length of lines varying from 15 to 40 mm., expressed in whole millimeters. Then I observed that lines approximately 25 and 35 mm. long were generally judged to be 25 and 35 mm. long, while in the case of other lines no such preference for certain figures was found. There was a bias in favor of the two quantities with which I had previously experimented.

This seems to disagree with the established fact that the differential

threshold decreases with increasing practice. This disagreement is, however, only apparent. We must remember that our judgment is a classification of the perceptions in classes of 1 mm. extent each. The greater frequency of the judgment "25 mm." and "35 mm." arises from the fact that I recognized these two lines more frequently than others, and that the great similarity of the line of 24 mm. to that of 25 mm. induces me to classify it under this heading, which is better known to me by practice. If the difference between the two lines should materially exceed the differential threshold, the result would, of course, be somewhat different. This phenomenon may be expressed psychologically: a new sensation is apperceived by means of similar sensations that form part of our knowledge.

As this is the most important part of our considerations, we will illustrate it by a few examples. It is well known that many languages lack a term for green. If we show an individual speaking such a language a series of green worsteds, he will call part of them yellow, another part blue, the limit of both divisions being doubtful. Certain colors he will classify to-day as yellow, to-morrow as blue. He apperceives green by means of yellow and blue. We apperceive odors in the same way, and classify new odors with those to which they are similar.

It will be understood that I do not mean to say that such sensations are not recognized in their individuality, but they are classified according to their similarity, and the classification is made according to known sensations. The difficulty and inability to distinguish two sensations is, however, as I indicated above, only an increase and the maximum of their similarity, which depends upon the similarity of the physical stimuli and the degree of attention. In the case discussed on page 3 we found the third factor to be the length of the interval between two sensations. In the present case it is the distinctness of the percept. The clearer the percept of the sensation the less likely it will be that another sensation is mistaken for it, and the less clear it is the more likely it is that such a mistake will take place.

We will apply this theory to the phenomena of mishearing. The speaker pronounces the word *fan*. The *f* will be approximately the average *f*. The hearer perceives a complex of sounds. There may be two causes for his mishearing the spoken word. First, the phonetic elements he hears are similar to other phonetic elements. Fortuitous circumstances may make the sensation somewhat deviate from

the average in the direction of another phonetic element, and thus it may happen that, instead of being classified under the proper heading, it is classified under an affiliated one. The classification is made according to the sounds that are known to exist in our language. Thus we find the *f* of *fan* frequently classified under the somewhat similar *th*. Second, the hearer does not know the meaning of the spoken complex of sounds, as there is no context, but he knows that they are intended to represent a certain word. Therefore when he hears the complex of sounds these are at once classified under one of the similar words, and this involuntary assimilation itself may influence the perception of the component sounds.

Far better material than that obtained in schools may be gleaned from the field-notes of philologists, who reduce to writing a language which they hear for the first time and of the structure of which they have no knowledge whatever. In this case men thoroughly trained in the science of phonology attempt to render by writing combinations of sounds to them without any meaning. The study of their misspellings cannot fail to be instructive.

The first phenomenon that strikes us is that the nationality even of well-trained observers may readily be recognized. H. Rink has demonstrated this very clearly in regard to Eskimo vocabularies, and proofs are so abundant that I may well refrain from giving examples. It is found that the vocabularies of collectors, although they may apply diacritical marks or special alphabets, bear evidence of the phonetics of their own languages. This can be explained only by the fact that each apperceives the unknown sounds by the means of the sounds of his own language.

Still more instructive are the misspellings of one and the same collector when he endeavors to spell the same word at various times. I will give here some examples gleaned from my own collections of Eskimo texts and words and of languages of British Columbia. The words are spelled in the alphabet of the Bureau of Ethnology:

ESKIMO.

Operníving	Upernívik	Uperdnívik
Kikertákdjua	Kekertákdjuak	Kekertáktuak
Nertsédluk	Neqtsédluk	
Kaímut	Kaívun	
Saúmia	Caúmia	

In the first of these examples the change between *o* and *u*, *n* and *dn*, *k* and *ng* will be noticed; in the second, the omission of the terminal *k*; in the third, the change between *r* and *q*; in the fourth, between *m* and *v*; in the last, between *s* and *c*. After I had studied the language more thoroughly I noted that the *n* is frequently pronounced the nose being closed. This gives rise to the alternating spelling *n* and *dn*. The *v* is not a dental labial, but a strongly sonant labial, being very similar to both *v* and *m*, and which was apperceived alternately by both these sounds. Finally I observed that there is a sound between *s* and *c*, being neither, which, however, I at first apperceived by means of these sounds. In 1886, when collecting some Tsimshian material, I spelled *păc*, fear. Later on I spelled the same word *bas*. Last summer, when studying this language more closely, I noticed that I had classified the surd-sonant first under *b*, later on under *p*. The *a* sound I found to average between *a* and *ä*; the *c*, similar to the corresponding Eskimo sound, between *s* and *c*.

I think, from this evidence, it is clear that all such misspellings are due to a wrong apperception, which is due to the phonetic system of our native language. For this reason I maintain that there is no such phenomenon as synthetic or alternating sounds, and that their occurrence is in no way a sign of primitiveness of the speech in which they are said to occur; that alternating sounds are in reality alternating apperceptions of one and the same sound. A thorough study of all alleged alternating sounds or synthetic sounds will show that their existence may be explained by alternating apperceptions. It is not necessary that the sounds are always apperceived by means of one's native language, at least not in the case of trained observers. In such cases the first studies of a language may form a strong bias for later researches, or the study of one language may occasion a bias in the study of the phonology of the language taken up immediately after. Every one of these biases tends to induce the collector to classify a sound which does not occur in the phonetic system he bears in mind, and is intermediate to several, alternately under those sounds which it resembles.

There is a crucial test for this theory; if it be correct, it must occur just as frequently that various sounds which resemble one known sound are considered the same, although they are really different. I observed this in Haida and in Kwakiutl, as well as in Eskimo. In the first there occurs a very slight hiatus, which I dis-

covered only with the greatest difficulty when I heard the words for "we" and "you" about twenty times without being able to discover the difference, the one being d'aléngua, the other daléngua. In Kwakiutl I found frequently the combination *gy*, but finally discovered that there are really two peculiar sounds, which I render by *ky'* and *gy'*. In Eskimo I found the same difficulty in distinguishing the *gdl* of Danish authors from the ordinary *l*.

The second and better crucial test is to attempt to ascertain whether individuals speaking one of these languages with "alternating sounds" hear sounds of our language as alternating sounds. This is, in fact, the case. Last summer I asked a Tlingit to pronounce the English *l*. I found that he alternately pronounced the exploded *l* of the northwest coast and *y*. In the same way he pronounced the German guttural *r* alternately as *r*, *w*, and *g*, and I may add here that a Scotchman whom I asked to pronounce the German word *süd* pronounced alternately *yūd* and *sūū'd*. I believe this crucial test is decisive; and it seems to me a sufficient explanation of the phenomena of "sound-blindness," as well as of "alternating sounds," to assume that they originate by "alternating apperception."

NEW YORK, *November*, 1888.

ONE MORE SKULL OF THE NEANDERTHAL RACE.—In Vol. 1, No. 3, of THE AMERICAN ANTHROPOLOGIST we spoke of the discovery at the Grotto of Spy, in Belgium, of two skeletons of the quarternary man of Europe, the race represented by the oft-quoted skulls of Neanderthal and Canstadt. We have now to record the discovery of another skull supposed to belong to the same race. It was found in 1887 in the bed of the Liane, in France, in making excavations for the foundations of the piers of a railroad viaduct. Unlike previously discovered remains of this race, this skull was not found associated with the bones of extinct animals, but with bones of existing species and varieties, which fact seems to show that the archaic race of Neanderthal survived in France until a—geologically speaking—recent period.

Dr. Hamy, to whose article, "Notice sur les fouilles exécutées dans le lit de Liane," etc., (*Revue d'Anthropologie*, May 15th, 1888,) we are indebted for our information, tells us:

"This head in its vault does not differ in any important char-

acteristic from those of the ancient race of which the Neanderthal skull is the most marked. We find in it the same elongated, flattened, general curves, the same exaggerated prominence of the superciliary arches and the occipital scale which have struck all anatomists from Messrs. Fuhlroth and Schaffhausen to Messrs. Fraipont and Lohest. In brief, it is in cranial construction a type of the most ancient quarternary. * * *

"The face of this remarkably archaic skull is particularly interesting to study. We are not sufficiently familiar with the features of the face of the Canstadt skull. The vault of our subject, reproducing in a striking manner the known characteristics of the vaults, more or less whole, that we are acquainted with in this race, allows us to suppose that the bony face, whose least detail is preserved, can give us an idea of the morphology of the corresponding portion of the skeleton of the primitive inhabitants of western Europe. But, if so, and if the facial characteristics of our subject have not been modified by some undetermined crossing, we must renounce many of our preconceived ideas of late years on the affinities of the Canstadt race. The head we are studying offers a certain degree of prognathisim, but it is about the only characteristic of inferiority it offers. We find none of the distinctive features of the negro and negroid races."

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"To resume: The excavations of the New Viaduct of the Liane have taught us that two varieties of horses, one more ancient and smaller, the other more modern and of the size of the Bonlonne horse now existing, succeeded one another on the shores of this river at an epoch undecided, but well anterior to the Roman occupation. This last horse was already crossed, as we find it to-day, with the Flemish horse, its northern neighbor. In company with the horse an ox belonging to the Batavian race of our own day, a goat which does not differ from our goat of to-day, inhabited the valley which was sometimes visited by small bears and by wolves of large stature.

A man lived in the midst of this fauna. He attained a height above the average. His bony frame was robust, his muscles powerful and vigorous. His cranial type has preserved archaic characteristics and recalls exactly that of the first-known inhabitants of western Europe. His features had, perhaps, already undergone under diverse influences modifications that were somewhat considerable. We know nothing of his industries nor of his manners, no object having been found with the bones which I have described. * * *." W. M.