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WITH REMARKS.

A CASE OF RESTRICTED RANGE OF
AUDITION.

BY

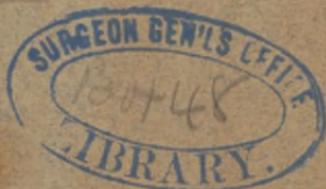
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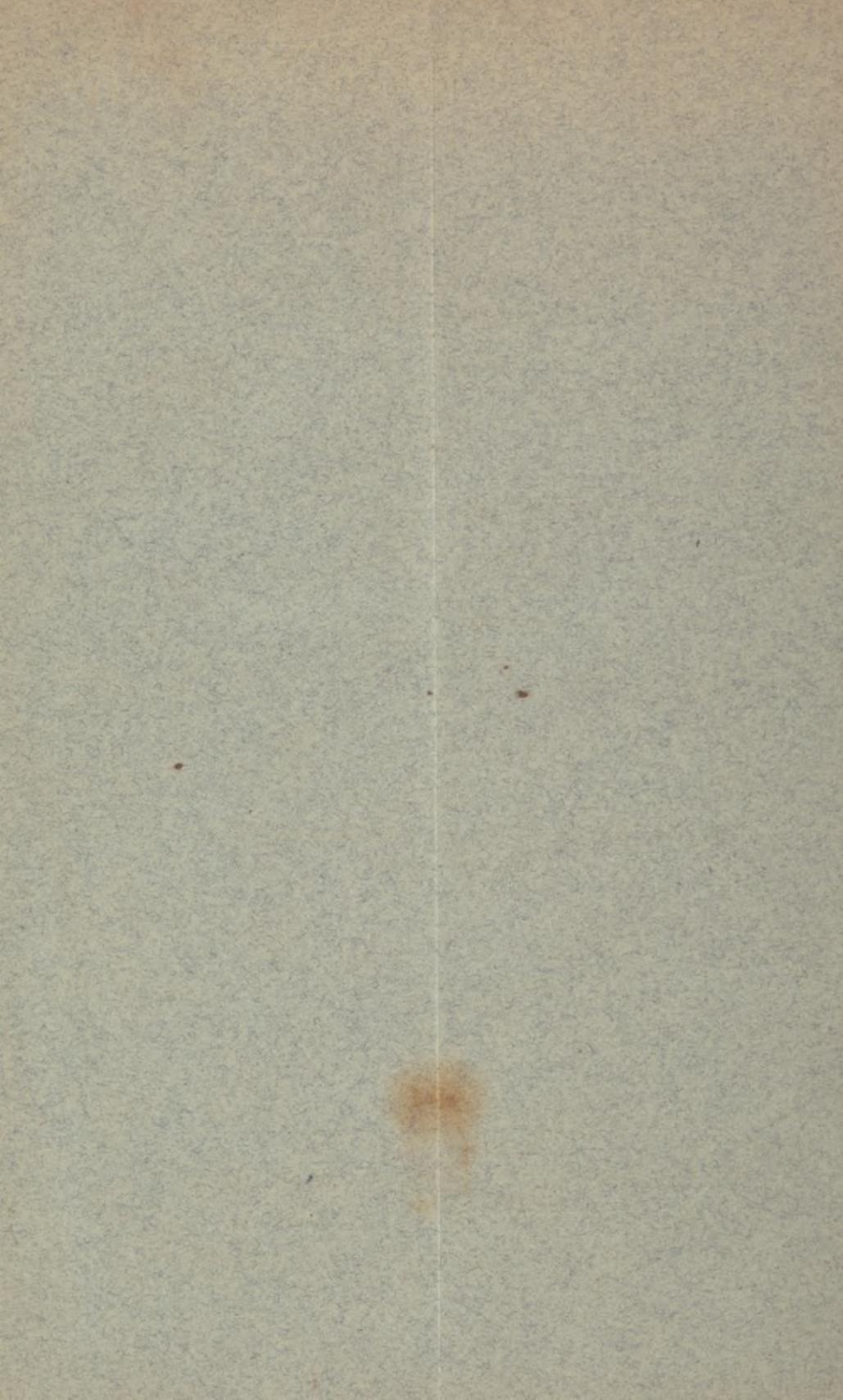
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*Reprinted from the "Archives of Ophthalmology and Otology,"
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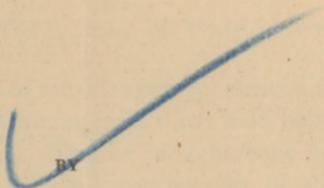
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A CASE OF DIPLACUSIS BINAURALIS, WITH REMARKS.

BY SWAN M. BURNETT, M.D., OF WASHINGTON, D. C.

G. K., a German professor of music, aged 59, noticed for the first time, about ten years ago, that an A tuning-fork, when held before the right ear, sounded from $\frac{2}{3}$ to $\frac{1}{2}$ a tone flat. This he thought to be very strange; but as it caused him no inconvenience in his profession, or otherwise, he paid but little attention to it, always employing the left ear in tuning instruments and when using the tuning-fork.

On being questioned as regards the circumstances under which this phenomenon made its appearance, he remembers at about that time, or previously, he noted a loss of hearing power, subjective noises, and some vertigo.

Since early life, however, he has been troubled more or less with vertigo even more than now, though he had a severe attack last spring. He also has had frequent attacks of "nervous headache," which were relieved by emesis or sleep. These headaches are now less frequent than formerly.

Seven months before calling my attention to his condition (July 29th, 1876), he accidentally noticed that the A fork, when held before the right ear, sounded as b natural, *one tone higher*. This change in the state of affairs arrested his attention, and he has since been observing it more closely, and, in the experiments carried on under my directions, the following facts have been elicited:

The A tuning-fork, as stated, when placed before the right ear is heard as *b natural*, but occasionally varies from that tone by one or two commas ($\frac{1}{3}$ to $\frac{2}{3}$ of a tone). When the fork is placed on the glabella, it is heard as *a*, but when on the mastoid process of the right side as *b natural*, the same as when held in front of the auricle. When the fork is placed on a sounding-board or on a common table, and the ears are applied to it, no difference is observed on the two sides.

On the piano a difference is noted, beginning at the contra A, which sounds in the right ear as *a sharp*, or about five commas higher. This difference lessens about one comma for each octave in ascending, until it disappears altogether.



The violin was used, held close to the ears, and the vibrations were made both by a bow and by plucking the strings, but no difference could be detected.

The same want of success followed experiments with wind instruments.

The timbre of the pseudo-tone of the fork and piano had, if there were any difference, a little less brilliancy than the tone as heard in the other ear.

His general health at present is good, except for a rheumatism of the right-side leg especially—an affection from which he has been a sufferer all his life.

A watch, which is heard at eighteen inches on the left side, is heard at one inch on the right. The membrana tympani is healthy in appearance; he has occasional noises, but there is no discharge from the ear, nor has there been at any time. About the time he first became aware of the diplacusis, however, he noticed that when he struck a note on the piano particularly hard, it gave a sensation of pain in the right ear. The Eustachian tube is pervious.

Accurately observed cases of diplacusis seem to be rare. Prof. *Knapp*, in these Archives, Vol. I., p. 365, records a case, and makes mention in more or less detail of the other cases that had been described up to that time. These cases comprise two recorded by *Moos*, and one by *von Wittich*.

In this paper *Knapp* gives a rational explanation of the phenomena of the affection in accordance with the present accepted views in regard to the physiology of music, and offers suggestions as to the proper study of cases that may come under notice in future—suggestions of which I have availed myself in the instance under consideration.

In order to obtain a clear understanding of the case just related, it will be best, perhaps, to repeat, briefly, the principles, physiological as well as pathological, that enter into a consideration of the subject.

The membrana spiralis, according to the theory of *Helmholtz*, is to be considered as a stringed instrument possessing a fibre which by its length and tension is tuned to each perceptible tone of the musical scale. The two cochleæ are tuned, in a normal condition, in unison.

In diplacusis binauralis there is supposed to be an inter-

ference in the tuning of one of the cochleæ, such as to destroy the harmony that should exist between the two, in order to insure binaural audition.

This interference may be such as to occasion a false higher, or a false lower tone in the affected ear.

In the case reported by *Knapp* the pseudo-tone was *lower* * than in the healthy ear, which would correspond to a tightening of the fibres. In von *Wittich's* case the pseudo-tone was *higher* with a corresponding relaxation of the affected fibres.

In our case the pseudo-tone was first *lower*, and, in accordance with this theory, associated with a *tightening* of Corti's fibres. Subsequently it was *higher*, with a corresponding *relaxation* of the affected fibres.

In von *Wittich's* case the diplacuis was limited to the middle octaves of the piano; in *Knapp's* to the middle and next higher; in ours it extended over about four octaves, beginning with the contra A.

In *Knapp's* case the difference between the two tones was two whole tones, and disappeared gradually; in von *Wittich's* it was one half-tone, and not variable; in ours it was not only variable from time to time, but changed with the octaves, varied with the character of the tones, and for some kinds of tones was not perceptible at all.

In all the reported cases, except in ours, there was an accompanying catarrh, acute or chronic, of the middle ear.

Any discussion of the pathology of diplacuis must, from the nature of the case, be entirely speculative in its character; and, while agreeing with *Knapp*, that "it is more important to collect facts in relation to this anomaly than to seek for a theory," we cannot but think that an examination of the facts thus far accumulated will not altogether fail to yield some good fruit.

In the cases hitherto reported there has been a high degree of probability that there was a propagation of a morbid process from the middle ear to the labyrinth, since in all there was present an

* There is an error in *Knapp's* report (l.c., p. 369), where he says that the tuning-fork was heard *higher* on the affected side. Further on he says it was heard *lower*, and from the context we judge this to be the case. In this same connection we would call attention to a singular mistake made by *Roosa*, in his reference to this case, in his textbook. In alluding to it, he says: "Both ears of this patient were affected with double hearing." (P. 490.)

acute or chronic otitis media. And if we accept the theory offered to us in explanation of the phenomenon, we have to deal with an exudation into the cochlea, or at least with an increase of intra-cochlear pressure. That the former is the morbid condition, would appear the more likely, since the false tuning has in all the cases been confined to a limited number of fibres, and does not affect them all, as must have been the case if there were a general increase in the pressure of the liquor Cotugni. That the latter might occur, however, cannot be denied.

It is a very pertinent question whether the symptoms accompanying diplacusis are such as we are accustomed to look for in cases where there is an increase of pressure on the terminal fibres of the auditory nerve.

In none of the cases have subjective noises, vertigo, etc., been at all prominent symptoms. In none of the cases hitherto recorded are these symptoms mentioned, and in ours they were by no means prominent, and the fact of their existence was elicited only by questioning. One feature in our case, which points to pressure in the labyrinth, is the *hyperæsthesia*, which was present early in the history of the affection, if we can accept as evidence of this the pain caused by loud sounds.

As to the character of the exudation causing pressure in these cases, it must either be inflammatory or sanguineous. In our case, if there were inflammatory action going on in the labyrinth, it must have been idiopathic—a fact denied by some writers; but, on the other hand, it lacked many of those intense features which have been asserted by those who contend for a primary inflammatory condition of the labyrinth to belong to the affection.

But, is it not possible that the changes which produce diplacusis may in some cases not be seated in the labyrinth at all, but in the cerebral centre of audition? We simply throw this out as a suggestion, and will reserve its further consideration for its proper place in a paper on the connection between nervous deafness and certain nervous affections.

There are some features of our case, peculiar to it, which are worthy of attention.

It is remarkable that the pseudo-tone varied with the different octaves and with tones of different timbre, and for some kinds of tones was not perceptible at all. In the experiments, it will be

noted that the nearer the tone approached to a simple tone—the fewer over-tones it had—the more pronounced was the pseudo-tone and the greater the interval between it and the tone as heard in the healthy ear. The difference between the two, when a tuning-fork was used which gives a simple tone, was one tone ; in the piano, in the lower octaves, where the over-tones are few, the difference was less marked, being one half-tone, but still greater than in the higher octaves where the over-tones are more numerous. In the violin, where the over-tones are many, no pseudo-tone could be detected. I have not been able to frame in my mind a satisfactory explanation of this curious fact. The nearest approach to it is this : If you take, for the pseudo-tone, a fundamental with a large number of over-tones, especially the middle and higher octaves, there are likely to be among these a number which, either in themselves or their harmonics, correspond to the fundamental of the tone as heard in the healthy ear. These over-tones will reinforce the tone as heard in the healthy ear, and give, so to speak, a *preponderance* to that tone. Applying here the principles that we have seen in action in strabismus, we can readily suppose that the false tone can be to a greater or less extent *suppressed*. In this manner we can satisfactorily explain why the diplacusic has never caused him any serious inconvenience. The suppression of the pseudo-tone is rendered the easier on account of its being much less intense than the tone as heard in the healthy ear, just as the more feeble of the double images in diplopia is more readily suppressed than the distinct one.

Bearing in mind these facts, we are able to infer that diplacusic may be a much more common affection than the record of cases would lead us to suppose, since it can be so readily overlooked. In our case it would never have been brought to light had the Professor not been accustomed to use the tuning-fork, and the difference in pitch would probably have passed unnoticed had he not been a musician.

A CASE OF RESTRICTED RANGE OF AUDITION.

BY SWAN M. BURNETT, WASHINGTON, D. C.

MRS. M. P. S., aged about 47, suffered from her infancy to her twelfth year with earaches, which, however, were never accompanied by a discharge.

The peculiarity in hearing under which she labors dates from her earliest recollection, and has never seemed to change from the time she first began to notice it until now. *This peculiarity consists in the inability to hear certain tones.* The singing of most birds is not heard by her at all; neither is whistling, unless it be in a low key; and she has never heard the chirp of a cricket. Words spoken in a whisper are totally incomprehensible to her. Bells of deep tone are readily enough heard, but small dinner-bells of high pitch are indistinguishable. Conversation, when carried on in an ordinary tone, is understood; but when words are spoken in a high key, as when one is speaking to an audience, she finds considerable difficulty in following the speaker. The ticking of some clocks is heard distinctly. When my watch (an English lever) was pressed strongly against the auricle, she experienced a sensation; but whether it was the auditory nerve or only the nerves of common sensation that were affected by the vibrations, it is difficult to say.

In testing on the piano, I found that she distinguished the notes one from the other very readily, until I came to the second C above the middle C of the instrument. All notes above this, she said, appeared to her alike; she could distinguish no difference between them. They had a low, dull, obscure sound, as if a table were tapped with the tip of the finger. The lower notes of the piano were much more brilliant in *timbre* than the higher.

The M.T., on inspection, were of the natural brilliancy. The light spot in the right was of the normal shape and position; in the left it was interrupted in the middle of its course; the Eustachian tubes were patent,—no evidence, in other words, of any present or past inflammatory trouble in the middle ear.

She has never in her life suffered from vertigo, and has never had any subjective noises.

Other members of her family have suffered from earaches; but she alone has this limitation in the range of audition. In her younger years she

learned music on the piano, but always played mechanically, and could never learn "by ear," though she strove hard to do so.

In addition to her defect in hearing, she has also a marked peculiarity in speech. None of the hissing sounds are pronounced. They are substituted by the smooth sound of *th*, or are glided over without any definite sound by the simple expiratory sound of *ha*. Thus the words Mister, Sampson would be pronounced *Mithter, Hamphthon*. It was a long time before she could learn to pronounce the word *champagne* correctly, calling it invariably *campagne*.

It is these words, too, where the hissing sounds occur, which she experiences the most difficulty in understanding. Sometimes they must be spelled or even written before she can comprehend them.

In her youth she had her frenum clipped by a surgeon, under the impression that her lisping was caused by tongue-tie. It is scarcely necessary to state that no relief followed the operation.

The perception of the higher musical tones and their pathological significance have already been treated of, *in extenso*, in these Archives, by the able pen of Dr. Moos (Vol. III., Part I., p. 113, and Vol. IV., p. 469), and it would be superfluous for us here to enter into a discussion of them. Besides, we are not sure that the case reported has any bearings in that direction. It is more than probable that the defect was congenital. It is true there was a history of earaches, but that history was not such, neither were the present indications such, as to point to a condition of affairs that would be likely to bring about the defect under consideration.

In all of Moos's cases there were subjective noises; in ours there were none, and never had been. The condition of the MTT. in Moos's cases was such as to lead to the diagnosis of "chronic catarrh of the middle ear," while no such evidence existed in our case. Moreover, we think that the fact that the limitation was abrupt and occurred at precisely the same note in each ear would militate against the idea of its being of pathological origin. It would be hardly probable that the modification of labyrinthine pressure from any pathological cause would be so exactly the same on both sides.

It is well known that the capacity for hearing very high notes is various in different individuals of otherwise normal hearing power, and also differs in different animals; and the only interest

that attaches to our case in that particular is, that the limitation is very much in excess of what is common.

The two points to which we would call attention, in connection with the case, are physiological rather than pathological.

It will have been observed in the history of the case that, though all notes above c''' (ut^4) ceased to be musical in their character and could not be distinguished one from the other, they were still, in a certain measure, perceptible.

This would appear to substantiate the theory that the perceptive auditory apparatus has two distinct functions with two separate organs for their performance. The office of one of these organs is to take cognizance of sound as noise, the other of sound as music. The cochlea is now accepted to be the organ for the perception of musical sounds, and in our case it is fair to presume that the fibres of that part of the lamina spiralis which corresponds to the higher notes are either absent or are in some manner hindered in the proper performance of their office; while that organ which presides over the perception of aërial vibrations as noise is to a greater or less extent intact.

The fact, that the lower notes of the piano were more brilliant in *timbre* than the higher, finds its explanation in the fact that the over-tones (which give the tone its brilliancy) of the upper notes lie largely in that portion of the musical scale which is beyond the limit of audition.

It is easy to trace the connection between the defect in hearing and the peculiarity of speech. It is certain that we make the sound of our own voices the guide to our articulation. If we cannot hear what we say, we cannot fashion the delicate and complex apparatus for articulation so as to enunciate the sounds we have in our minds to utter. The lady, whose case we have been considering, having never heard the hissing sounds, is not able to judge whether she articulates them or not, and the consequence is that they are either glided over or substituted by some other sounds which appear to her mind to be their equivalents.

It is not improbable that many cases of "lispering" have their origin in this same condition of the auditory apparatus; and in all such cases it would be well to make an examination of the range of audition.

