BINAURAL SPEECH AUDIOMETRY

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Binaural speech audiometry gives a better insight than monaural speech audiometry into the auditory discriminatory functions of the patient. It is more related to hearing under normal circumstances, it is more physiological. The data, obtained with the binaural method have more bearing on acoustic behaviour in general; as an extra result, a differential diagnosis is offered to the examiner between a peripheral and a central deafness.

To begin with the last statement: the type of collaboration between the two organs of hearing depends upon the localisation of the hearing deficiency, whether it is situated before or after the first meeting point in the central nervous system. According to Galambos, this should be the superior olivary nucleus. If the deficiency is located after the olive (third or fourth neuron), the perceptive deafness is called central and the two organs show a form of addition which is more or less comparable to that in normal individuals, e.g. the binaural curve has the same form as the monaural one and it is shifted parallel to the latter, usually in the direction of increased sensitivity. If the deficiency is located before the olive (cochlea, first or second neuron), the perceptive deafness is called peripheral and the two organs show a form of addition which is significantly different from the first type in that the binaural curve has a different form; it is steeper than the monaural curves (usually by a factor of 2).

In the last case the binaural curve is the product of the compound probability of two independent probability functions which produces a steeper curve than in the first situation where but one bottleneck existed, located in or beyond the olive. In the normal individual the threshold is located centrally; it does not matter whether the total energy is fed into one ear or distributed in a certain proportion between the two ears. The discrimination curves always show the same form, thus pertaining to one and the same probability function resulting from a single threshold mechanism, which thus must be located in or after the first meeting point of the central connections of the two ears (Chocholle).

The binaural method uses the same technique as monaural speech audiometry, with this difference: there need to be two independent channels, one for each ear, each with its own attenuator. The method provides so-called diotic hearing, consisting of an identical presentation to the ears. First the monaural discrimination curves are determined, whereafter the binaural curve is obtained by starting at the level of 50 % monaural discrimination score. If the two ears are too different to react at the same intensity level, a compensation is necessary to obtain the optimal match. In practice it has appeared

that the necessity for compensation between two ears, which are different according to pure tone audiometry, occurs far less than would be expected from these tone audiograms. Usually the binaural curve is determined first for low speech intensity levels. By reducing in steps of 5 db from the monaural 50 % level downwards the initial slope is found. This part is of importance for diagnostic purposes (see above). Then the other part is explored by increasing the speech level from the monaural 50 % level onwards.

This binaural test has been applied to 146 cases of perceptive deafness, 112 of which were children between the ages of 4 and 20. According to the criteria: steeper or parallel binaural discrimination curve, the material could be grouped as listed in table I.

Cause of deafness	Peripheral	Central	Total
Acquired	6	14	20
Partus	5	13	18
Congenital	5	12	17
Pregnancy	6	5	11
Hereditary	1	8	9
Meningitis	5	—	5
Rhesus antag.	—	4	4
Contusio cerebri	1	2	3
Streptomycin	—	2	2
Unknown	7	16	23
Total number of cases	36	76	112

Table I

Those cases, the clinical diagnosis of which was known to be of a peripheral deafness (noise trauma, meningitis) produced steeper binaural curves, thus confirming the hypothesis of a peripheral deafness according to our criteria.

On the other hand perceptive deafness as a consequence of Rhesus antagonism. The diagnosis proved its purely central origin: binaural parallel to monaural curves.

Apart from the diagnosis, the following phenomena deserve special mentioning.

1. The binaural score is usually better than the monaural one; the discrimination loss is reduced to about one half of the monaural loss.

2. The useful dynamic range is often increased, the binaural capacity for handling loud sounds is usually far better.

3. The binaural measurements show less scattering than the monaural data; the patients show more certainty, the hesitation, manifest during the monaural test, has almost disappeared during the binaural situation. Also they respond quicker.

All the results are grouped in table II.

Phenomenon	All cases %	All cases db	Peripheral %	Peripheral db	Central %	Central db
Threshold ↙	100	6.0 ± 2.5	100	8.8 ± 4.0	100	4.0 ± 2.5
Threshold ↙ (favourable cases)	70	8.9 ± 3.5	85	11.0 ± 5.0	69	6.4 ± 2.7
Improvement of discrimination ↗	47	1.87 ± 0.53	52	1.75 ± 0.60	44	1.95 ± 0.50
Upper limit ↘	12	11 ± 5.0	12	9 ± 4	9	12 ± 5
Upper limit ↙	23	10 ± 5.0	43	10 ± 4	11	10 ± 5
Steepness increase	32	—	100	1.82 ± 0.36	0	—
Bin. scattering/ mon. scattering	100	0.79 ± 0.27	100	0.78 ± 0.37	100	0.80 ± 0.22
Recruitment	44	yes	64	yes	34	yes
Recruitment	56	no	36	no	66	no
No improvement	13		15		12	
Hindrance	5		—		9	

Table II

AUDIOMETRIE VOCALE BINAURALE

L'audiométrie vocale offre la possibilité de distinguer entre une surdité de perception centrale et celle d'origine périphérique. Les courbes d'intelligibilité monaurales et binaurales sont comparées; si la courbe binaurale possède la même forme et inclinaison initiale que les courbes monaurales, il s'agit d'un cas de surdité centrale; si la courbe binaurale est plus raide que les courbes monaurales, il s'agit d'un cas de surdité périphérique. La méthode est fondée sur la coopération binaurale qui ne commence que dans le noyau olivaire supérieure. Si la déficience est située dans la voie centrale après ce noyau les organes d'ouïe collaborent comme chez les normaux: la courbe binaurale est déplacé parallèlement de 3 (ou plus) db en rapport avec la courbe monaurale. Si la déficience est située dans la voie, commencant après l'étrier et se terminant dans l'olive, la coopération interaurale se comporte comme le résultat des deux probabilités indépendantes, ce qui explique l'inclinaison plus raide de la courbe binaurale.

L'applicabilité est limitée aux enfants qui veulent répondre; il n'est pas nécessaire qu'il savent la langue; du moment qu'ils réagirent seulement comme un perroquet la méthode est applicable. Nous avons examiné 112 enfants âgés de 4 à 20 ans (élèves de l'école des enfants malentendants à Utrecht), qui avaient tous une surdité de perception. Selon notre norme 36 des cas avaient une déficience périphérique et les autres 76 une déficience centrale. Il apparait, qu'en ces cas, où le diagnostic clinique était déterminé soit d'une surdité cochléaire ou centrale, notre diagnostic tait d'accord. En 3 cas de traumatisme sonore (une déficience certainement cochlaire), nous avons trouvé une inclinaison plus raide de la courbe binau-

rale d'un facteur 2.0, donc appartenant à une surdité périphérique. Le Rhésus antagonisme produit des cas d'une surdité centrale.

Un méningite (pas traité avec streptomycine) détruit les nerfs partiellement: en 5 cas nous avons trouvé un surdité périphérique.

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