

## Acceptability of binaural hearing aids: a cross-over study

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### Summary

Using screening questionnaires we were able to detect individuals aged 50-65 years with hearing disability in a general practice population. Those who had better ear hearing levels of 30 dB or worse were invited to take place in a cross-over study comparing the acceptability of a monaural or binaural hearing-aid fitting. Fifty-five per cent ultimately opted for a binaural fitting and had greater hearing disability and worse mean hearing levels than those who opted for a monaural fitting. They made their choice for acoustical reasons, particularly on the basis of improved localization ability.

### Introduction

Many studies have examined the benefits of binaural hearing-aid fitting<sup>1,2</sup>. However, with the exception of a recent report on a study in progress in Glasgow<sup>3</sup>, there has been little investigation of the acceptability of such a fitting.

This paper describes the results of a study in which the acceptability of binaural hearing aids by a hearing impaired population detected by a screening programme has been examined. The study formed part of a larger research programme concerned with the detection of hearing disability in a pre-retirement population and the willingness of those with such a disability to accept rehabilitative intervention<sup>4</sup>.

### Method

#### Subjects

Ninety-seven per cent of all patients (588/604) aged 50-65 years registered with two general practices in the Upper Afan Valley in West Glamorgan replied to a questionnaire about hearing problems. All who indicated a hearing disability were invited for an audiological assessment ( $n=289$ ) and those with mean hearing levels equal to or worse than 30 dB in their better ear, (averaged over 500, 1000, 2000 and 4000 Hz) ( $n=49$ ), and who had not previously used a hearing aid, were then invited to take part in a cross-over study on binaural hearing aids. Data are presented for 29 of the 49, there being 11 refusals, and nine did not complete all the sessions.

#### Procedures

Appropriate impressions were taken from each ear on the initial visit. Half the subjects were then randomly assigned to a monaural hearing-aid fitting to their preferred ear and half to a binaural fitting. The procedures performed at each visit are summarized in Table 1.

At the initial visit, a variety of questionnaires were administered, measuring auditory disability for speech

Table 1. Procedure carried out on each visit

	Visit 1	Visit 2	Visit 3	Visit 4	6/12 F.U.
Audiometry and impressions	+	-	-	-	-
Social Hearing Handicap Index	+	-	-	+	-
Emotional Response Scale	+	-	-	+	-
Fitting	-	+	+	-	-
Localization questionnaire	+	-	+	+	+
Benefit/problem questionnaire	-	-	+	+	+
Satisfaction questionnaire	-	-	+	+	+
FAAF (speech in noise test)	-	-	+	+	-
Preference questionnaire/extended preference questionnaire	-	-	-	+	+

(Social Hearing Handicap Index - SHHI<sup>5</sup>), emotional response to hearing loss (ERS) and a localization disability questionnaire (both derived from the Hearing Measurement Scale<sup>6,7</sup>).

At the second visit, the first fitting (monaural or binaural) took place with appropriate instruction of the subjects in the use of their hearing aid(s). All patients were fitted with UK National Health Service BE18 postaural hearing aids with appropriate earmoulds, vented or open as indicated in the individual case.

The third visit took place 4-6 weeks after the first fitting. At this visit the localization questionnaire was readministered with the subject instructed to respond as with his/her current hearing aid fitting. A satisfaction/benefit questionnaire was also administered.

Next the four alternative auditory feature FAAF speech in noise test<sup>8</sup>, presented at a signal noise ratio of 0 dB, was administered unaided and also with the aid fitting the individual had been using for the first 4-6 weeks.

Finally those monaurally fitted were changed to a binaural fitting and those binaurally fitted with their preferred ear monaural fitting.

The fourth session (4-6 weeks later) was similar but, in addition, after the subjects had been asked whether they wanted to continue using one or two aids, they

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were also administered a questionnaire asking the reasons for their final choice, and whether they preferred one aid or two under a variety of different conditions. The Social Hearing Handicap Index and Emotional Response Scale were also re-administered.

## Results

### Experimental and demographic factors

Sixteen of the 29 subjects who completed the study (55.2%) opted for two hearing aids. There was no significant difference between the proportion of individuals fitted with two aids first and those fitted with one aid first, who ultimately opted for a binaural fitting. There was no age difference between those opting for two aids and no significant difference between the sexes. However, only six females completed the study, and it is of note that whereas 61% of the males ultimately opted for a binaural fitting, four of the six females chose a monaural fitting.

### Pre-fitting predictors

We next examined a variety of audiometric and disability variables which might have influenced the outcome. Those who chose to keep two aids had significantly worse hearing in the right ear and in the better ear averaged across the four frequencies 500 to 4000 Hz (better ear 38.7 dB vs 33.0 dB;  $t=2.25$ ;  $P<0.05$ ; right ear 42.5 vs 35.0;  $t=2.5$ ;  $P=0.03$ ). Individual frequencies differed significantly at 2000, 3000, 4000 and 6000 Hz ( $P<0.02$ ), separately in both left and right ears and also when considered in terms of better and worse ears. The mean better and worse ear audiograms for the two groups are shown in Figure 1. There was no difference in the asymmetry of the hearing loss either averaged across frequencies, for individual frequencies, or in terms of a measure of the asymmetry of the slope of the audiogram in the two ears.

The Social Hearing Handicap Index Score, was significantly worse in the group opting for binaural aids ( $t=3.44$ ;  $P<0.002$ ). This relates to the audiometric differences between the two groups, as several studies have shown a high correlation between the speech disability scale scores and audiometric thresholds, particularly in the mid and high frequencies<sup>9,10</sup>. On the other hand, the Emotional Response Score (ERS), a measure of handicap, did not differ significantly between the two groups. The localization questionnaire, likewise did not differ between the two groups, supporting the results of the measures of asymmetry of the hearing loss.

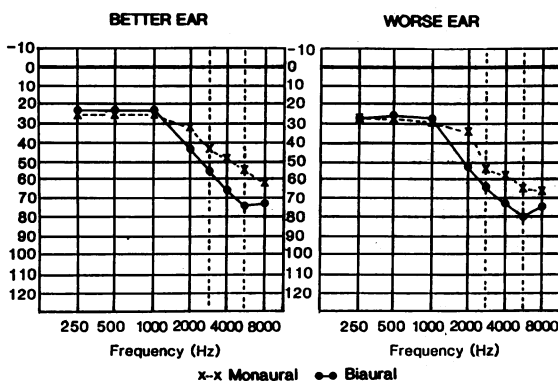


Figure 1. Mean better and worse ear hearing thresholds for those choosing binaural and monaural hearing aids

Table 2. Discriminant function analysis between binaural and monaural users significant predictors

Predictor	Wilks Lambda	Significance
SHHI	0.76	0.01
BEHL	0.70	0.02
WEHL	0.64	0.02
ERS	0.60	0.05

We then performed a discriminant function analysis on the possible predictors of monaural and binaural choices. We examined the better and worse ear hearing levels, the Social Hearing Handicap Index score and Emotional Response Scores, the localization scores, age and sex. The significant discriminant factors are shown in Table 2 from which it may be seen that the most important discriminant is the disability as reflected in the SHHI score.

### Outcomes

We next examined the changes in the various measures after the patients had used the different hearing-aid fittings. The SHHI and ERS were re-administered only after the final choice, and the post-fitting measure of these scales did not differ significantly between groups. However, both scales showed significant improvements in both groups (SHHI  $t=5.75$ ;  $P<0.001$ ; ERS  $t=3.05$ ;  $P<0.006$ ).

The localization measures were obtained for each fitting after the subject had used that fitting for 4-6 weeks. The only significant differences between the scores in the groups was an improvement in localization score in the binaurally aided condition compared with the unaided condition ( $t=3.87$ ;  $P<0.001$ ).

With the measures of speech discrimination in noise (FAAF) we compared the unaided with the aided conditions in each test session. The overall unaided scores were better in the monaural group than the binaural group because of their better hearing ( $t=2.99$ ;  $P=0.006$ ). However, there were no significant differences between groups in changes after fitting. Likewise there were no significant differences between the groups in the satisfaction questionnaire, although in both these and the FAAF results there was a tendency for an improvement in the condition associated with the final choice of hearing aid.

When asked for the reasons for their choice, and here the subjects were allowed to give as many reasons as they wished, by far the commonest responses (53% of all responses) in the binaural group were based on acoustical reasons - clarity, localization, loudness, etc. The monaural choice group, however, showed more of a scatter of reasons, opting for such a fitting on the basis of convenience, psychological and acoustical reasons (Table 3).

When asked which hearing aid fitting, monaural/binaural/no difference they preferred for specific circumstances or reasons, all those opting binaurally favoured such a fitting for all the listening conditions. The monaural group opted for monaural aids similarly, except for localization where they reported little difference. On the basis of self-consciousness, monaural users preferred a monaural fitting, but binaural users found no difference. Finally for handling problems neither group reported a difference between monaural and binaural fittings (Table 4).

Table 3. Numbers of subjects giving specific reasons for choice of fitting

Reason	Choice	
	Monaural	Binaural
Convenience	4	1
Comfort	2	2
Cosmetic	1	0
General	6	4
Hearing	4	10
Psychological	4	2

### Discussion

The benefits of binaural amplification have been considered in a number of studies. They include improved speech in noise discrimination and localization of sounds in the horizontal plane, together with loudness summation, tinnitus suppression and a psychological feeling of being in a 3-dimensional auditory world. There have been various considerations of those deriving or not deriving such benefits, mainly related to the age and symmetry of the hearing loss, but even this has been beset with controversy<sup>11,12</sup>.

Swan<sup>3</sup> recently, in a preliminary report on a clinical study in Glasgow in which patients presenting at a hearing aid clinic were offered binaural aids and then followed up, found that some 60% of those under the age of 75 years, accepted a binaural fitting, with a very low acceptance rate in those older than 75. None of his patients had used hearing aids before and all had better ear hearing levels of 40 dB or worse. He found only age and initial attitude to be predictors of binaural acceptance.

Our population differed in that they were of a much narrower age range, had not presented to a clinic with hearing problems and, generally had milder hearing losses  $\geq 30$  dB BEHL. We also used a very different experimental methodology. The interesting finding was that a similar proportion of our patients preferred binaural aids but, perhaps because of our limited age range, a significant age effect was not found in the present study. The significant effect of hearing level which we found may relate to the mild losses included

Table 4. Responses to preference questionnaire by choice

	Choice	
	Monaural favoured fitting	Binaural favoured fitting
Localization	E/M	B
Speech in noise	M	B
Speech in quiet	M	B
TV/radio	M	B
Traffic	M	B
Sound quality	M	B
Selfconsciousness	M	E
Controls	E	E

E, Monaural/binaural equally preferred; M, monaural favoured; B, binaural favoured

in our study as 78% of our patients had losses less than Swan's criterion for inclusion.

Neither Swan nor we found any effect of asymmetry between the ears on the acceptability of binaural fittings, a matter which has aroused some controversy in the context of binaural benefits<sup>11,12</sup>.

The choice made by the subjects reflected the benefits which they obtained from that particular fitting whether as reported by questionnaire (problem/benefit questionnaire) or by psychoacoustical testing. However, there was a tendency for greater reduction in auditory disability in terms of speech hearing difficulties (SHHI) and localization amongst those using two aids rather than one.

The reasons given by the patients for their ultimate choice when asked, free of constraints to specify these were notably acoustical by those opting for binaural aids. Those opting for a monaural fitting reported a wider range of reasons.

### Conclusion

Overall within this population of middle aged subjects with relatively mild hearing losses detected by a screening programme, 55% ultimately opted to use two hearing aids. Those opting for a binaural fitting tended to have greater hearing disability associated with worse hearing, and showed greater reduction in localization disability with such fittings. They made their choice predominantly for acoustical reasons.

Those opting for one aid had less hearing disability, milder hearing losses, and demonstrated less benefit from two aids. The reasons for their choice were more varied.

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