Subjective and Objective Correlates in a Hearing Aid Evaluation Procedure

Dorothy E. Grant, M.S., VA Hospital, Ann Arbor
Yolphe B. Yopp, Ph.D., Univ. of Michigan
Baxton Millburn, Ph.D., VA Hospital, Ann Arbor

Ross (1972) in a review of the literature concerning hearing aid evaluation procedures reported several different clinical methods which have been used to guide the audiologist in selecting the most appropriate amplification for their hearing-impaired clients. According to a survey done by Burney (1972), the most popular of these methods used in clinics today is the Carhart method which was first described in 1944. Nearly 85 percent of the more than 200 clinics responding to Burney's questionnaire used the Carhart approach with relatively few modifications as the basic hearing aid evaluation procedure. Essentially this method of hearing aid evaluation explores four dimensions of hearing aid performance: effective gain, tolerance limits, efficiency in noise and word discrimination. In this procedure, selection of a specific hearing aid for the client is made on the basis of a compilation of scores obtained on several instruments from tests designed to measure these four aspects of hearing aid performance. If scores happen to be similar for two or more aids tested, factors such as size of the aid, its weight, its aesthetic qualities and its cost often come into the picture to help the audiologist make the decision as to which aid should be recommended for purchase.

Only recently has consideration in the literature been given to other ways of determining which is the "best" of two similarly performing hearing aids. One suggestion that has been made is that subjective evaluation, that is listener judgement, be used as an indicator of the efficiency of the hearing aid (Zerlin, 1962; Witter and Goldstein, 1971). The difficulty in using listener judgement as a reliable indicator of efficiency is that we are not sure of just how reliable the judgement really is. However, to point in time, we have been unable to resolve these seemingly unmeasurable effects that cause a person to choose one aid in preference to another. Yet the importance of listener preference persists.

Ross (1971), Burney (1972) and Chaiklin and Nauser (1968) have suggested that clinical observation seems to bear out a positive correlation between "best" performance and listener preference but that too little systematic investigation has been reported in this area.

**Method**

The purpose of this study was to investigate the question of listener preference as a factor in the hearing aid selection process. A hearing aid evaluation procedure was studied in which subjective preference for amplification was compared with objective rating in an ideal listening situation and in listening situations contaminated by two kinds of noise. Subjects were twelve male veterans of the United States armed ser...
Vets who had sustained hearing loss during or as a result of their tours of duty. Each was eligible to receive a hearing aid through the Veterans Administration and was being seen for this purpose at the Audiology Clinic at the Veterans Administration Hospital at Ann Arbor, Michigan. Ages of the subjects ranged from 21 to 70 years. Pure tone audiometric configurations allowed the subjects to be placed into one of three categories: a mixed loss group, a group with a sensori-neural perceptual loss of hearing acuity beginning at 2000 Hz, and another group with a more gradual loss of sensitivity throughout the test frequencies.

Procedure: Testing was done in a double walled IAC testing suite in the clinic. The equipment used consisted of a Gram-Slader speech audiometer, model 152, and its associated amplifier and speaker. Taped CID W-2 word lists were used as the speech discrimination test material and were played through the Gram-Slader system from a Viking 425 tape deck. The noise source was the black channel of the speech audiometer set at either the wide band white noise or the speech spectrum white noise condition.

The two "best" performing hearing aids as determined by the traditional Carhart approach were selected for each subject. The performance of these two aids were compared according to the following protocol: 1. Speech reception thresholds: 2. Speech discrimination scores in quiet at a 0.5 decibel sensation level re: 505. 3. Speech discrimination scores in wide band white noise with a signal to noise ratio of 1:1 at 40dB SL, 4. Speech discrimination scores in speech spectrum white noise with signal to noise ratio of 1:1 at 40dB SL, and 5. The veteran's subjective evaluation, or ranking, of the two aids according to his impression of the quality of the signal as he compared the aids in the quiet listening environment.

Results and Discussion

The means for each patient group reported in Tables 1 and 2 show that the speech reception threshold scores and the speech discrimination scores were essentially the same in quieter conditions although subjects in each category were usually able to rank them according to quality of the amplification.

Table 3 shows that discrimination scores in the wide band white noise condition had a mean difference of 14.3 percent between the first and second ranked aids for the total group of subjects whereas the discrimination scores in speech spectrum white noise were markedly reduced for both hearing aids for all three hearing loss categories. It is of great interest to note that eleven of the twelve subjective preferences for the aid with the best sounding quality were in agreement with the best objective performances in wide band white noise contamination.

In a traditional hearing aid evaluation procedure it is appropriate and necessary, for selection of the most efficient amplification as well as for screening purposes, to include a measurement of hearing efficiency in a less than ideal listening environment. A listening environment in which wide band white noise is used seems to serve this requirement quite well and is easily available in the clinician's traditionally equipped audiology clinic. Because of the greatest sound pressure levels associated with speech spectrum white noise at various attenuator dial settings, it appears from the results of this
<table>
<thead>
<tr>
<th>GROUP</th>
<th>Aid 1</th>
<th>Aid 2</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>16.57</td>
<td>16.57</td>
<td>0</td>
</tr>
<tr>
<td>S/N P.</td>
<td>6.00</td>
<td>10.00</td>
<td>2</td>
</tr>
<tr>
<td>S/N G.</td>
<td>15.43</td>
<td>15.14</td>
<td>0.27</td>
</tr>
<tr>
<td>Total*</td>
<td>14.50</td>
<td>14.56</td>
<td>0.06</td>
</tr>
</tbody>
</table>

* Means from unequal scores of all subjects.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>Aid 1</th>
<th>Aid 2</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>85.33%</td>
<td>94%</td>
<td>4.67%</td>
</tr>
<tr>
<td>S/N P.</td>
<td>85.00%</td>
<td>81%</td>
<td>4%</td>
</tr>
<tr>
<td>S/N G.</td>
<td>86.00%</td>
<td>79.75%</td>
<td>6.25%</td>
</tr>
<tr>
<td>Total</td>
<td>85.50%</td>
<td>81.66%</td>
<td>3.84%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Aid 1</th>
<th>Aid 2</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>64%</td>
<td>29.33%</td>
<td>44.67%</td>
</tr>
<tr>
<td>S/N P.</td>
<td>66%</td>
<td>48%</td>
<td>18%</td>
</tr>
<tr>
<td>S/N G.</td>
<td>57.71%</td>
<td>50.85%</td>
<td>6.86%</td>
</tr>
<tr>
<td>Total</td>
<td>60%</td>
<td>45.66%</td>
<td>14.34%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TYPE</th>
<th>Aid 1</th>
<th>Aid 2</th>
<th>DIFFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed</td>
<td>28%</td>
<td>12%</td>
<td>16%</td>
</tr>
<tr>
<td>S/N P.</td>
<td>40%</td>
<td>29%</td>
<td>11%</td>
</tr>
<tr>
<td>S/N G.</td>
<td>36%</td>
<td>26.29%</td>
<td>9.71%</td>
</tr>
<tr>
<td>Total</td>
<td>32%</td>
<td>24.66%</td>
<td>7.34%</td>
</tr>
</tbody>
</table>

63
study that this type of noise at the 1.1 signal to noise ratio is almost totally
devastating to the discrimination ability of the hearing impaired listener in
both aided and unaided conditions. While this reading are the same for the two
types of noise, sound pressure levels at the component frequencies are quite
different. The results of the present study indicate that wide band white noise
contamination at 1.1 signal to noise ratio effectively differentiates between
hearing aid performances which were not differentiated in the quiet envi-
rornent. In addition, eleven of the twelve (91.6 percent) subjects in the study
showed subjective preference for the aid which performed best on the objective
wide band white noise measurements.

In view of the current controversy regarding the dispensing of hearing aids
by audiologists it becomes apparent that any improvement in techniques of
hearing aid evaluation would be to the advantage of the clinician. And as Ross
(1972) indicated, until electrophysiologic methods of determining the best aid for an
individual become available, updating the present procedures with
modifications of the traditional approaches to hearing aid evaluation seem to be
in order. Note studies in conjunction with the client's subjective preference for
an aid seem to give useful information to the audiologist in this regard.

Summary

A hearing aid evaluation procedure was studied in which subjective
preference for amplification was compared to objective test results obtained in
an ideal listening situation and in listening situations contaminated by two
types of noise. Wide band white noise contamination was found to effectivly
differentiate between hearing aid performances which were not differentiated in
the quiet environment. 91.6 percent of the population of the study showed
subjective preference in quiet for the aid which performed best on the more
objective wide band white noise measurements.

Acknowledgement: This study was supported in part by V.A. Hospitals
Research funds.

REFERENCES

Burrey, P.A., A survey of hearing aid evaluation procedures. ASHA. Sep-
tember, 1972.

Chaislin, J.B., and Stassen, B.A., Distorted perception of speech in hearing aid

Ross, M., Hearing aid evaluation. In Katz (Ed.), Handbook of Clinical

Witter, H.L., and Goldstein, D.P., Quality judgement of hearing aid

S., A new approach to hearing aid selection, Journal of Speech and