FALSE POSITIVE DP GRAMS

Prof. Dr / Mona mourad
Dr / Samir Asal

Introduction
Distortion-Product Otoacoustic Emissions (DPOAEs) are acoustic energy in the ear canal arising from the non-linear interaction of two simultaneously applied pure tones of frequencies $f_1$ and $f_2$ within the cochlea. DPOAEs are thought to be generated mostly at the place of greatest overlap of the traveling waves that result from the two pure tone stimuli.

When $f_2/f_1$ ratio of 1.2, also $L_1$ is 5-10 dB > than $L_2$.

The largest DPOAEs amplitude are elicited.

DPOAE can be recorded in almost any normal-hearing subject and in subjects with hearing loss up to 50 dB HL.

At severe and profound hearing loss, the use of DP grams may be misleading.
Aim of the work

The aim of this work is to determine the levels of $f_1$ and $f_2$, (primaries) at which DPOAEs only reflect active, nonlinear mechanical processes in the cochlea.
Materials and Methods

Study Groups
Alex University H&C

1- group (A): {adult, age>20 years}
   A1  7 ears with normal hearing
   A2  7 ears with profound to total SNHL

2- group (B) {children, age 2-12 years}
   B1  7 ears with normal hearing
   B2  7 ears with profound to total SNHL

3- group (C) {infants, age <2 years}
   C1  4 ears with normal hearing
   C2  4 ears with profound to total SNHL

4- dummy cavity (D) that simulate adult EAC
All subjects in this study underwent the following:

1- Detailed history taking and family history of hearing loss.

2- Otologic examination to exclude any external ear pathology.

3- Assessment of hearing threshold using Pure Tone Audiometry in groups A and B and ABR in group C

4- Distortion Products Otoacoustic Emissions (DP gram)
Two pure-tone signals, f1 and f2 (f1<f2; f2/f1=1.22), were presented simultaneously as primary tone frequencies that generate 2f1-f2 DP.

DP-gram was collected at 3 points /octave steps at stimulus levels so that L1>L2 by 10 dB. The first levels of the primaries used were 80 dB SPL for L1 & 70 dB SPL for L2 then the levels decreased by 5 dB step until L1= 60 dB  L2= 50 dB

Results and Discussion
### Table (1): Age of study groups

<table>
<thead>
<tr>
<th>Group</th>
<th>Age Group</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (adult)</td>
<td>Group A1</td>
<td>33±3.6</td>
</tr>
<tr>
<td></td>
<td>Group A2</td>
<td>34±4.1</td>
</tr>
<tr>
<td>Group B (child)</td>
<td>Group B1</td>
<td>5±2.5</td>
</tr>
<tr>
<td></td>
<td>Group B2</td>
<td>6±3.2</td>
</tr>
<tr>
<td>Group C (infant)</td>
<td>Group C1</td>
<td>1±.5</td>
</tr>
<tr>
<td></td>
<td>Group C2</td>
<td>.8±.6</td>
</tr>
<tr>
<td>dummy cavity (D)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table (2): Descriptive statistics of hearing thresholds in dB

<table>
<thead>
<tr>
<th>Group</th>
<th>Pure Tone Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A (adult)</td>
<td>Group A1</td>
</tr>
<tr>
<td></td>
<td>Group A2</td>
</tr>
<tr>
<td>Group B (child)</td>
<td>Group B1</td>
</tr>
<tr>
<td></td>
<td>Group B2</td>
</tr>
<tr>
<td>Group C (infant)</td>
<td>Group C1</td>
</tr>
<tr>
<td></td>
<td>Group C2</td>
</tr>
</tbody>
</table>
The subject is considered as passing the DP gram test when the DP levels are above the noise floor at all frequencies by 5 dB and DP levels are > -10 dB (i.e. normal DP-gram) as in (Fig. 1). If the DP levels are within the noise at all frequencies, it is considered failed DP-gram (Fig 2).

![Fig (1) pass DP gram](image1)

![Fig (2) failed DP gram](image2)

**Dp grams results of group (A) {adult} and (D) {dummy cavity simulating adult EAC}**

- **Level 1**
  - f1 = 80 dB
  - f2 = 70 dB

- **Level 2**
  - f1 = 75 dB
  - f2 = 65 dB

- **Level 3**
  - f1 = 70 dB
  - f2 = 60 dB

- **Level 4**
  - f1 = 65 dB
  - f2 = 55 dB
Dp grams results of group (B) {children}

Level 1  f1= 80 dB  f2 = 70 dB

![Graph showing DP grams results for Level 1 with f1 = 80 dB and f2 = 70 dB.

Level 2  f1= 75 dB  f2 = 65 dB

![Graph showing DP grams results for Level 2 with f1 = 75 dB and f2 = 65 dB.

Level 3  f1= 70 dB  f2 = 60 dB

![Graph showing DP grams results for Level 3 with f1 = 70 dB and f2 = 60 dB.

Level 4  f1= 65 dB  f2 = 55 dB

![Graph showing DP grams results for Level 4 with f1 = 65 dB and f2 = 55 dB.

Dp grams results of group (B) {children}
Dp grams results of group (C) {infants}

Level 1  \( f_1 = 80 \) dB  \( f_2 = 70 \) dB

Level 2  \( f_1 = 75 \) dB  \( f_2 = 65 \) dB

Level 3  \( f_1 = 70 \) dB  \( f_2 = 60 \) dB

Level 4  \( f_1 = 65 \) dB  \( f_2 = 55 \) dB

All ears in the three groups with total SNHL showed pass DP grams at \( L_1=80/L_2=70 \) dB, \( L_1=75/L_2=70 \) dB, and \( L_1=70/L_2=60 \) dB and failed DP gram at intensity levels \( L_1=65/L_2=55 \) and below these levels.

In other hand all ears with normal hearing in the three groups showed pass DPOAEs at all intensity levels examined.
The presence of false positive Dp grams at high intensities (≥ 60-70 dB SPL) is due to either

1- passive nonlinear macro mechanical properties of the cochlea

   Or

2- acoustic interaction of the two primaries in EAC

The presence of positive DP gram in the cavity simulating EAC suggest that false positive DP gram at high intensity is due to acoustic interaction of the two primaries in the EAC
Distortion product otoacoustic emissions (DPOAE) elicited by tones below 60-70 dB SPL are significantly more sensitive to cochlear insults. The vulnerable, low-level DPOAE have been associated postulated active cochlear process.

Whereas the DPOAE at high intensities of the primaries is due to acoustic interaction of the two tones in the EAC.
in conclusion, for purely audiometric purpose, DPOAEs turn out to be rather insensitive to hearing loss whenever stimulus levels equal or exceed 60 - 70 dB SPL.

THANK YOU

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