WHO Safe Listening App: Review and Features

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INTRODUCTION OF HÖRTECH GMBH

- Founded 2001 in Oldenburg as a non-profit company
- Majority stakeholder: University of Oldenburg
- Goals:
  - Interface between science and industry
  - Development of new methods and expertise
  - Support of science and research
  - HörTech is the transfer organization of the Cluster of Excellence Hearing4all
WHO SAFE LISTENING APP FOR MOBILE DEVICES

- **Purpose of the app:**
  - Educate users of their recreational listening habits
  - Give users a feeling for sound level and sound dose
  - Provide a ball park estimate of the daily sound dose obtained through listening with the mobile device

- **The app cannot:**
  - Precisely measure the dose
  - Include other sound sources than the headphones of the mobile device
  - Measure the sound exposure from other apps on the phone
  - Prevent users from unsafe listening
Features of the App

- Developed for Android and iOS
- Typical music player functionality
- Notifications at reaching certain doses (50%, 75%, 90%, and 100%)
- Notification at startup
- Smart volume: automatic level reduction at higher dose values
- Statistics:
  - Doses of the past days
  - Today’s listening time
  - Average sound level
A QUICK TOUR OF THE APP
HOW DOES IT WORK?
Dosimetry guidelines are given for the free field. Diffuse field compensation by subtracting transfer function from free field to occluded ear:

\[ L(f)_{\text{ear canal}} = L(f)_{\text{digital}} + C_{\text{handset}} + (1 - V)L_{\text{attenuation}} + C_{\text{headphone}} \]

- Total acoustic energy obtained by summing energy over frequencies, resulting in \( L_{\text{free field}} \)
**OBTAINING THE DOSE FROM THE LEVELS**

- Maximum allowed exposure time (in minutes) at level $L$ according to occupational noise exposure guidelines from U.S. Department of Health and Human Services (NIOSH, 1998):

$$T(L) = \frac{480}{2^{(L-85)/3}}$$

![Graph showing the relationship between maximum allowed time and level (dB_A).]
The app tracks the exposure time $E_L$ for each level $L$.

$$Dose = \sum_{L} \frac{E_L}{T(L)}$$

38.3%
In order to realistically estimate the sound pressure levels provided by a range of headphones and handsets, we

- measure with rubber ear simulators
- calibrate a range of phone volume settings
- allow third parties to add headphones and handsets
CALIBRATION

- Measurement of SPLs for different handsets, headphones and volume settings
- Pink noise at -18.2 dB digital level
- B&K 2610 amplifier, G.R.A.S KEMAR 45BA artificial head, G.R.A.S 42AA Pistonphone

![Levels for Nexus 5X phone, Android 6.0.1](image-url)

- Sound pressure level (dB A)
- Volume setting
- $C_{\text{handset}}$
- $C_{\text{headphone}}$
- $L_{\text{attenuation}}$ (handset-dependent)
CALIBRATION

- Calibration constants can be added to a database of devices
  - Device calibration $C_{\text{handset}}$
  - Volume attenuation $L_{\text{attenuation}}$
  - Headphone calibration $C_{\text{headphone}}$

### Apple iPhone 6s

- **KOSS (cheap, on-ear)**
- **Apple (earbuds iPhone)**
- **JVC HA-RX500 (full-size around-ear)**

Sound pressure level (dB A) vs. Volume setting for Apple iPhone 6s.

### Settings

<table>
<thead>
<tr>
<th>Calibration</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device calibration</td>
<td>117.26 dB</td>
</tr>
<tr>
<td>Volume attenuation</td>
<td>53.06666 dB</td>
</tr>
<tr>
<td>Headphone calibration</td>
<td>-4.1 dB</td>
</tr>
</tbody>
</table>
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