Physiologically steered hearing aid devices rely on the principle of utilizing bio-electrical signals, recorded from a contact point close or inside the ear, aiming to extract relevant information that can be used to manipulate settings or parameters of the hearing device. For this reason, it is important to know to what extent the environmental conditions, to which the recording electrodes will be exposed, can impact the quality of the bio-electrical signals of interest.

**Background & Hypothesis**

Auditory Steady State Responses (ASSR) can be measured by placing recording electrodes inside the ear cavity [1-3]. Extensive ear preparation of lab-based ear recordings is incompatible with realistic long-term recordings.

The use of dry-contact electrodes is a potential platform towards real-life applications of electrophysiologically steered devices [5], but little is known about the impact of an uncleaned or unprepared ear on the quality of in-ear recordings.

We hypothesized that presence and production of cerumen inside the ear would have a negative impact in the quality of ASSR recorded from the ear.

**Methods**

Four Auditory Steady State Responses and two Resting State Noise-Roofs from 8 participants were recorded with dry-contact electrodes [5]. Recordings were done both, before and after cleaning and preparing the ears, with a replicates 3 weeks later to allow for cerumen recovery. The amount of cerumen present in the ear was evaluated using an otoscopic camera before both recording sessions and rated by 3 clinical experts.

**Procedures**

ASSR
- Duration: 5 minutes
- Stimulus: Dicite White Noise
- Modulation Freq: 40Hz
- Reference: Forehead
- In-Ear electrode: 1 in concha, 1 in canal

Resting State
- Duration: 5 minutes
- Stimulus: Silence
- Reference: Forehead
- In-Ear electrode: 1 in concha, 1 in canal

Otoscopic Inspection

Usually via an OTOScan. Photos of the ear cavity recorded for ranking.

Ear Cleaning
1. Cotton swab wax removal
2. NuPrep abrasive cleaning
3. Alcohol swab cleaning
4. Cotton Swab water rinse
5. Drying

Data Analysis
- 2X4 repeated Measures ANOVA to assess ASSR responses (forehead referenced and in-ear referenced).
- Spearman’s rank correlation to assess the amount of cerumen vs ASSR amplitude

**Results**

**Test-re-test reliability**

<table>
<thead>
<tr>
<th>Test-Visit</th>
<th>Intra-class correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 2</td>
<td>0.994</td>
</tr>
<tr>
<td>2 to 3</td>
<td>0.998</td>
</tr>
<tr>
<td>3 to 4</td>
<td>0.989</td>
</tr>
</tbody>
</table>

**Repeated Measures ANOVA**

- ASSR SNR (DB)
- In-ear Reference Resting State Noise-floor
- Main Effect of Ear
  - Current effect: F(1, 28) = 16.808, p = 0.00032

- Ear Cleaning
- Effect of Time*Ear Condition
  - Current effect: F(3, 168) = 4.929, p = 0.00263

- Spearman’s Rank Correlations

**Discussions & Conclusions**

We hypothesized that presence and production of cerumen inside the ear would have a negative impact in the quality of ASSRs recorded from the ear.

ASSR responses were significantly larger when measured from an electrode placed in the concha than in the ear canal. Presence of cerumen in the ear had a positive impact, lowering the power of the resting state noise-floor, which increases the probability of capturing smaller ASSR responses.

No significant correlation was found with respect of the amount of earwax present before the recordings and the ASSR SNR for the noise-floor level.

With this small cohort of participants, there is no evidence to support the need for ear preparation before in-ear electrophysiological recordings with dry-contact electrodes in the ear.

This is a positive finding towards the realization of physiologically steered hearing devices.