Lateralization of Virtual Sound Sources with a Binaural Cochlear-Implant Sound Coding Strategy Inspired by the Medial Olivocochlear Reflex*

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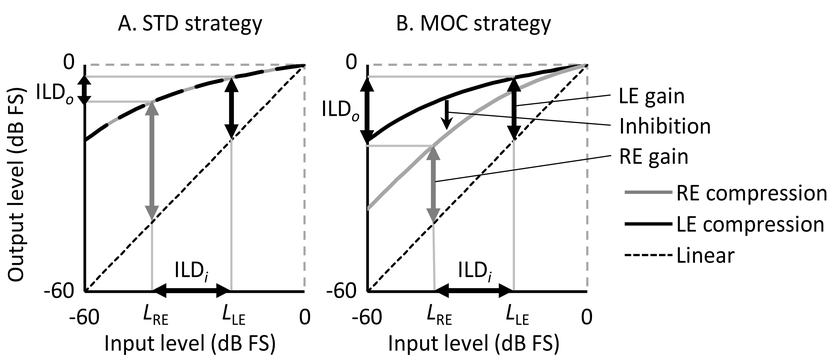
Introduction and Aims

The MOC strategy is a binaural cochlear-implant (CI) sound coding strategy that uses binaurally coupled, dynamic back-end compression inspired by the medial olivocochlear reflex [**1**]. Here, we investigate the potential benefits of the MOC strategy for localizing sound sources in a virtual horizontal plane.



Aim 1. To compare sound source localization in the horizontal plane with the MOC and with the standard (STD) strategy involving two functionally independent devices.
Aim 2. To compare sound source localization performance for various implementations of the MOC strategy designed to reflect more or less realistically the inhibitory characteristics of the natural contralateral MOC reflex [**2**].

Methods

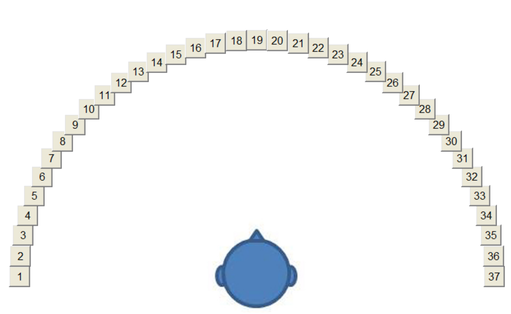
Participants

N = 12 bilateral MED-EL CI users.

Stimuli

- Gaussian noise bursts bandpass filtered between 125 and 6000 Hz (fourth-order in MED-EL US or first-order in Salamanca Butterworth filter).
- Stimulus level: -20 dB full scale (FS).
- Stimulus duration: 240 ms, including onset and offset ramps (20-ms MED-EL US or 50-ms Salamanca).
- Simulated free-field conditions with KEMAR HRTFs: 0˚ elevation, for 11 azimuthal angles from –75˚ to +75˚ separated by 15˚.

Procedure



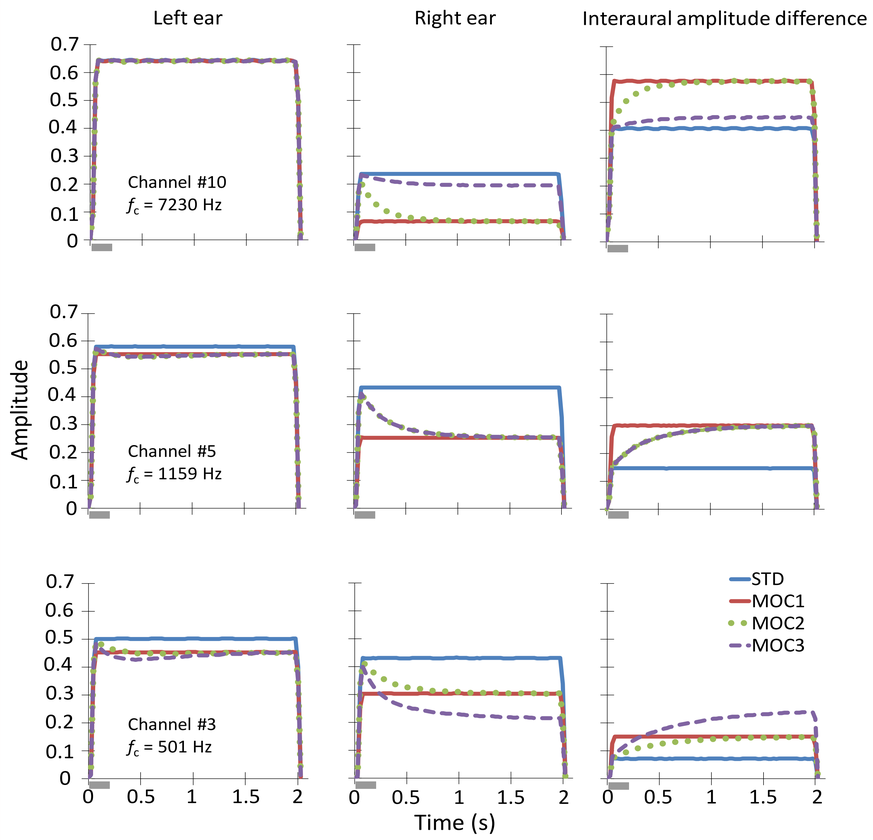
Response screen as shown above. No feedback given.

Processing Strategies

- **STD.** Two independently functioning processors (the current ´clinical´standard).
- **MOC1.** Fast (2 ms), on-frequency control of compression as tested so far [**1, 3, 4**].
- **MOC2.** Slower (~300 ms) MOC1 strategy, closer to the natural MOCR [**5**].
- **MOC3.** MOC2 strategy with greater inhibition in the lower than in the higher frequency channels, closer to the natural contralateral MOCR [**6**].

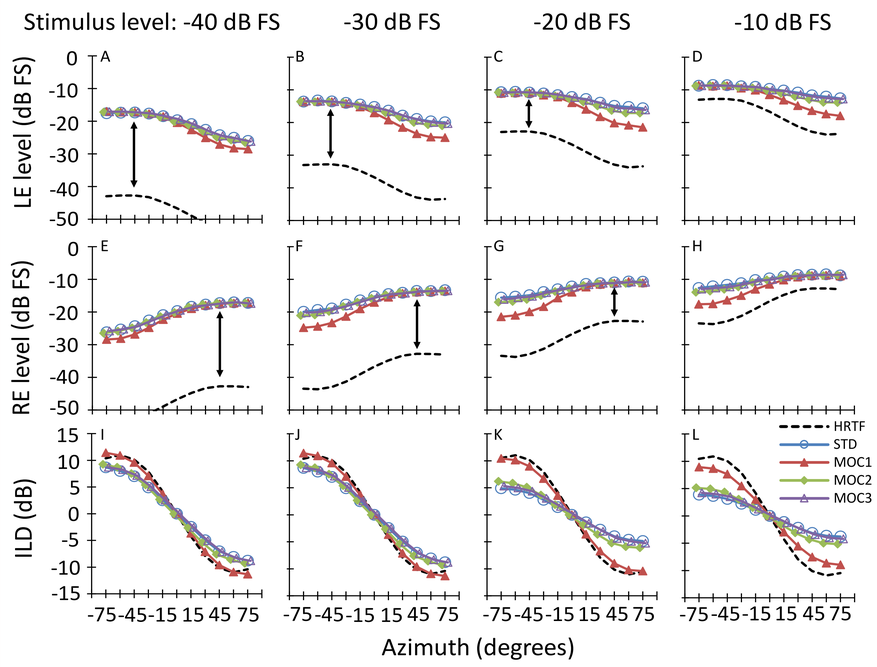
Results. Level cues provided by the STD and MOC strategies

Output envelopes for a sound source at -60˚ azimuth



1. Output amplitude: greater for the left than for the right ear.
2. Right ear: amplitude greater/equal for the STD than for MOC strategy.
3. Contralateral inhibition: faster for MOC1 than for MOC2 or MOC3 strategies.
4. Interaural amplitude difference: equal/greater for any MOC strategy than for STD strategy.
5. Different MOC processors produced different interaural amplitude difference across frequency channels depending on wheather or not they involved bandwidth normalization.

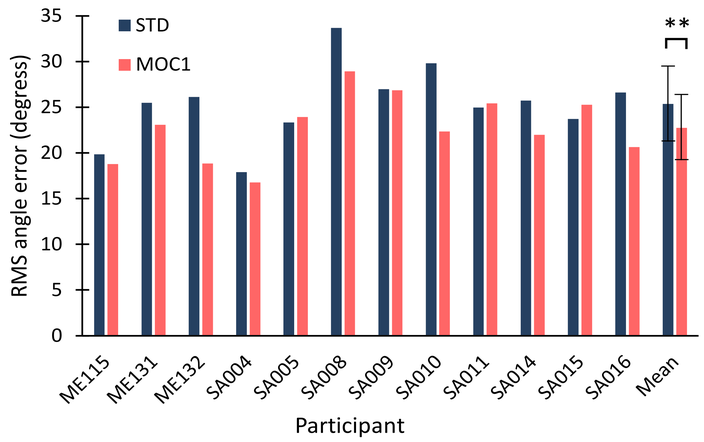
Output level and interaural level differences (vocoded stimuli)



1. For all strategies: the output level at each ear increased with increasing stimulus level.
2. The difference between the input (HRTF) and the output levels decreased with increasing stimulus level.
3. At each ear, the MOC1 strategy preserved to a larger extent the monaural HRTF level localization cues across the stimulus levels tested.
4. The MOC1 strategy produced ILDs that were: (1) largest; (2) closest to the HRTF ILD, and (3) roughly constant across stimulus levels.

Results. Aim 1

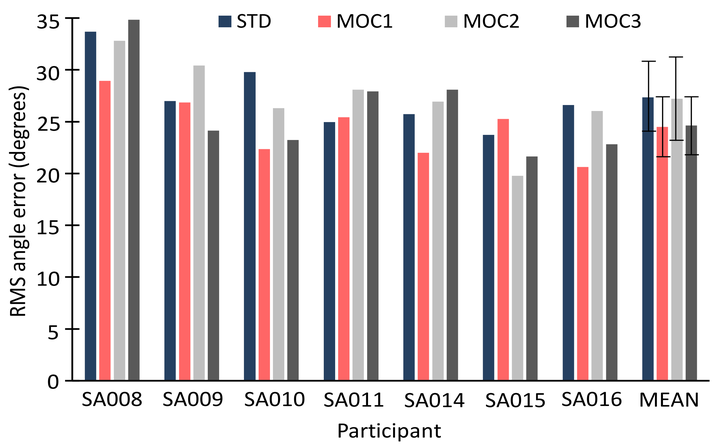
Localization angle error scores for the MOC1 and STD strategies



- The group mean angle error score was smaller for the MOC1 (mean ± s.d. = 22.7°±3.6°) than for the STD (25.3°±4.1°).

Results. Aim 2

Localization performance with the different strategies



- The more realistic MOC3 implementation tended to improve localization relative to the STD strategy, but this difference was not significant probably because stimuli were too short (200-ms).

Conclusions

1. Compared to a STD strategy, the MOC1 strategy slightly improved the localization of wideband (125–6000 Hz) noise bursts in a virtual horizontal plane.
2. The MOC2 and MOC3 strategies provided larger ILDs than the STD strategy for sufficiently long stimuli (>1 s). However, for shorter (200-ms) noise bursts, the localization performance with these strategies was not significantly different from that with the STD strategy.
3. The localization improvements observed for the MOC1 strategy are probably due to this strategy providing larger and less ambiguous ILDs than those provided by the STD strategy.

Aknowledgements

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