

Correlation between otoacoustic emission and behavioral estimates of contralateral medial olivocochlear efferent inhibition in humans

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Motivation and aims

The medial olivocochlear reflex (MOCR) linearizes basilar membrane input/output (I/O) curves [1]. In human, the magnitude of this effect can be assessed only indirectly by measuring, for example, the increase in absolute thresholds [2,3], or the decrease in the levels of transient-evoked (TEOAE) [4] or distortion-product otoacoustic emissions (DPOAE) [3] caused by contralateral MOCR elicitor sounds. Our aims were:

- (1) to investigate whether those methods yield comparable results at the group and individual levels;
- (2) to compare the sensitivity and reliability of those methods.

Assumptions

- The MOCR can be activated by contralateral acoustic stimulus (CAS).
- A contralateral 60 dB SPL broadband noise (BBN) activates the MOCR but not the middle ear muscle reflex.
- The MOCR is fully active 500 ms after elicitor onset [5].

Methods

CAS

- BBN: 10 Hz - 10 kHz.
- Duration: 850 ms.
- Started 500 ms (abs. thresholds) or around one second (OAEs) before the probe.

OAE I/O curves

- N=17 (27.6 ± 7.4 years).
- TEOAEs
 - 1024 clicks (19/s).
 - Levels: 51.3:60 dB pSPL.
- DPOAEs
 - L₂ = 30:5:50 dB SPL.
 - f₂ = 1, 1.5, 2, 3, 4 kHz.
 - Kummer L₁-L₂ rule [6].
 - 10 sweeps (300-ms tones).
- Third-tone used to suppress DPOAE fine structure [7].
- Four interleaved measures without (CTR) and with CAS in one session.
- Valid if SNR ≥ 6 dB.
- ER-10D probe.

- Post-hoc requirement: at least 3 valid pairs of (CTR, CAS) measurements.

Absolute thresholds

- N=27 (27.5 ± 7.7 years).
- 14 left ears, 13 right ears.
- ≤ 20 dB HL in both ears at 125–4000 Hz.
- Monaural pure tones: 300 ms, 0.5, 1.5 and 4 kHz.
- 3AFC, 2-down, 1-up. 71% psychometric function [8].
- 3 paired (CTR, CAS) measures in different sessions/days.
- ER-2 transducer.

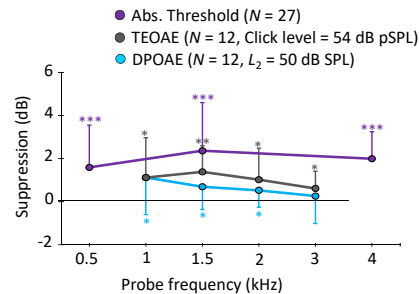
TEOAEs

- N=27 (same as above).
- 75-μs, 54-dB pSPL clicks.
- Click rate: 19/s.
- 1024 clicks.
- Four interleaved (CTR, CAS) measures in one session.
- Valid if SNR ≥ 6 dB.
- Measured in both ears.
- ER-10D probe.
- FFT analysis performed.

Results. At group level

Is CAS suppression significant?

Yes, for the three measures.

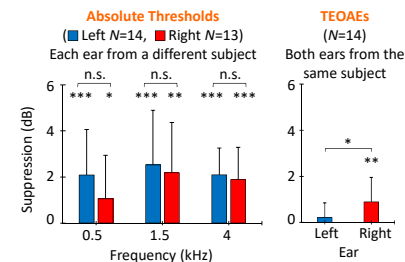


Is suppression different across frequencies?

- No. The three measures suggested slightly, but not significantly, larger suppression at frequencies ≤ 1.5 kHz than at higher frequencies.
- Trends were similar for other levels (L₂=40 and 45 dB SPL, and for 60 dB pSPL clicks).

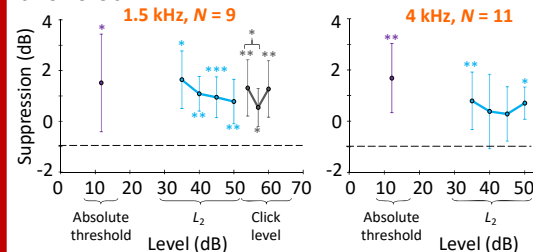
Is suppression different across ears?

CAS reduced TEOAE levels in the right but not in the left ear, but increased absolute thresholds similarly in the two ears.



Is suppression different across levels?

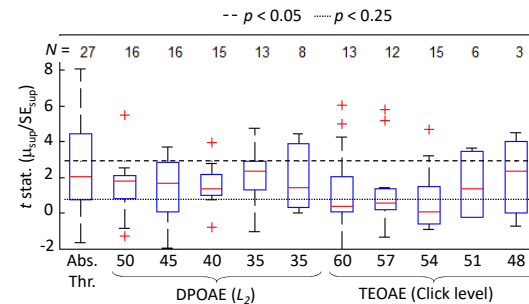
Absolute threshold suggested larger suppression than DPOAEs or TEOAEs. Perhaps threshold measures involved lower levels.



Results. At individual level

What is the most sensitive method?

Absolute threshold: it produced the largest proportion of subjects showing significant suppression.



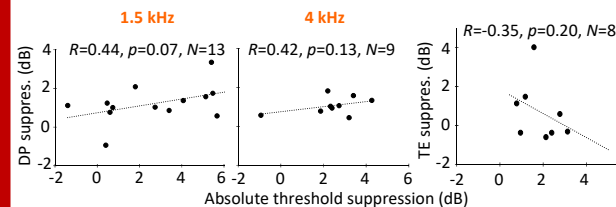
Very few subjects showed significant suppression.

Table 1. % subjects who showed significant CAS suppression with each method at different p levels (one-tailed, paired t test).

p	Abs.Thr.	DPOAEs					TEOAEs				
		50dB	45dB	40dB	35dB	30dB	60dB	57dB	54dB	51dB	
0.05	48	6	24	6	18	18	16	12	7	12	
0.25	74	71	59	76	65	24	21	29	22	24	

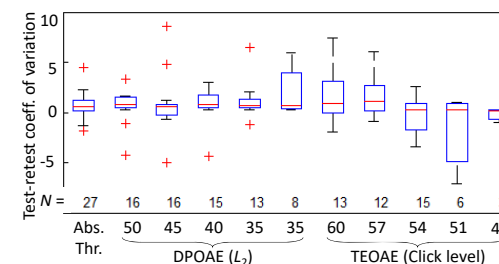
Suppression was not correlated across measures

Based on subjects showing significant suppression at p = 0.3.



What method is more reliable?

Absolute thresholds and DPOAEs: they produced smaller test-retest variability across 3 (or 4) measures of suppression.



Discussion

Results were consistent with those in the literature

- Similar magnitude of suppression of TEOAEs [4,9], DPOAEs [3,9] and absolute threshold [2].
- Greater suppression at mid frequencies [3,10] or at lower than at higher frequencies [9].
- Greater suppression of TEOAEs in the right than in the left ear [11].

Correlation across methods

- Different methods suggested broadly similar CAS suppression on average...
- ...but not at the individual level.

Which method to use to assess suppression?

- Hard question: methods give uncorrelated results.
- Reason uncertain: OAE and/or absolute thresholds affected by temporal fine structure? Attention? Central masking?
- Assuming all methods do measure MOCR suppression, the choice would be best guided by practical aspects.
- Absolute threshold and DPOAE appeared more sensitive and reliable than TEOAE.

Key findings

- Absolute thresholds, DPOAE and TEOAE produce consistent results at group level...
- ... but are not equivalent for assessing MOCR suppression.
- Absolute thresholds and DPOAE appear more sensitive and reliable than TEOAE.

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References

- Cooper NP, Guinan JJ (2006). *J. Physiol* 576, 49-54.
- Aguller E et al. (2015). *Front Syst. Neurosci.* 8, 251.
- Kawase T et al. (2003). *J. Exp. Med.* 200, 129-135.
- Collet L et al. (1989). *Hear. Res.* 43, 251-262.
- Backus BC, Guinan JJ (2006). *JASA* 119, 2889-2904.
- Kummer P et al. (1998). *JASA* 103, 3431-3444.
- Johnson TA et al. (2006). *JASA* 119, 3896-3907.
- Levitt H (1971). *JASA* 49, 467-477.
- Lisowska G et al. (2014). *Clinical Interv. in Aging* 9, 901-914.
- Lilaonitkul W, Guinan JJ (2009). *JARO* 10, 459-470.
- Bildelman GM, Bhagat SP. (2015). *Integrative systems*, 483-487.

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