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Distortion Product Otoacoustic emmission fine structure of symphony orchestra musicians

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Introduction

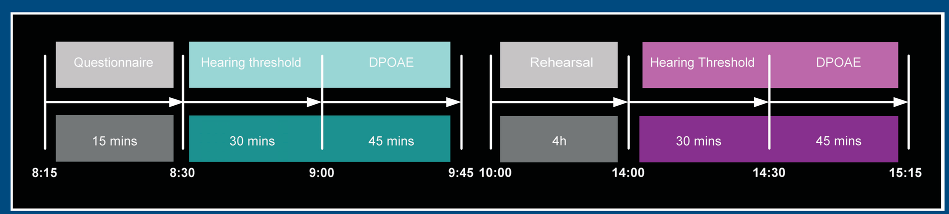
In this study distortion product otoacoustic emission (DPOAE) were measured with a high frequency resolution for a group of musicians before and after rehearsal. The high frequency resolution reveals a fine structure [1-11], which is the result of two or more distortion product sources on the basilar membrane. The primary component comes from a place close to f_2, and the seondary (reflection component) from the $2f_1$-f_2 site. The fine structure will be more or less pronounced, depending on the strength relations between the two components, which again depends on the state of hearing (e. g. OHC damage).

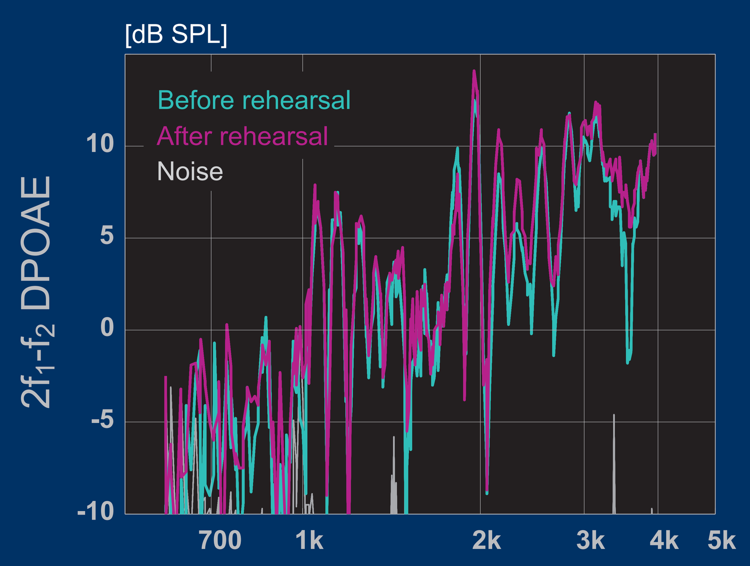
The purpose was to study any temporary effect from rehearsal, and to study any preliminary permanent effect from work-conditioned exposure. For details, see [12].

Methods

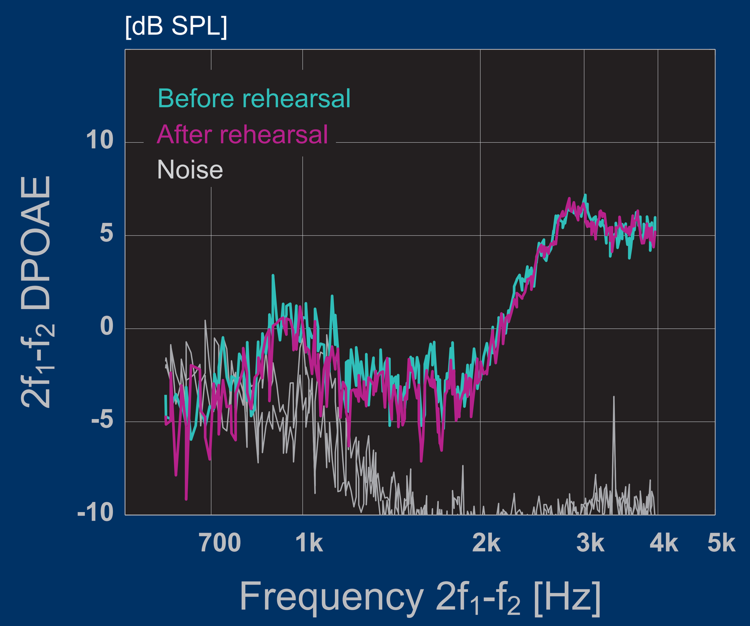
$2f_1$-f_2 DPOAE measurements were done with the ILO96: L_1/L_2 = 65/45 dB, f_2/f_1 =1.22, 903 Hz >f2 > 6201 Hz, Δf = 12 Hz for f_2 < 3 kHz and Δf = 22 Hz for f_2 < 3 kHz. 12 musicians aged 31-55 (mean 39) participated, Hearing thresholds were measured using standard audiometry.

One subject participated per rehearsal day. Each session lasted 90 minutes, 30 minutes for the pure-tone audiometry and 60 minutes for the measurement of DPOAE fine structure. The order of testing either hearing threshold or DPOAE first was balanced.





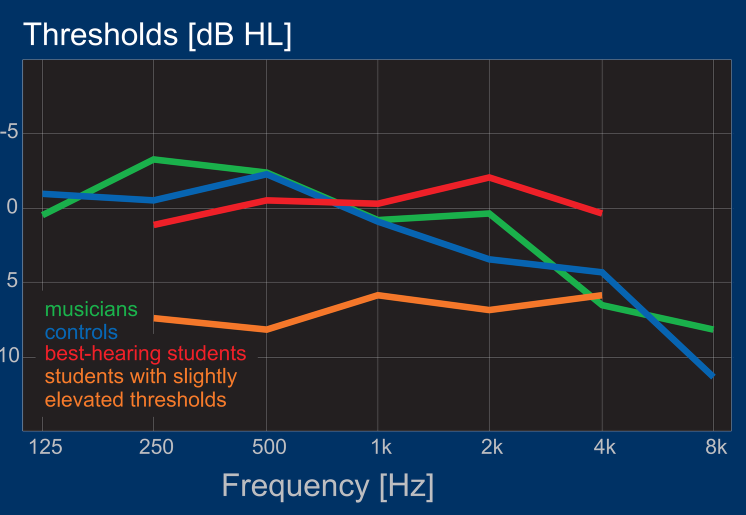
DPOAE measurement for one subject before and after rehearsal. The example features fine structure characteristics with deep notches and high peaks.



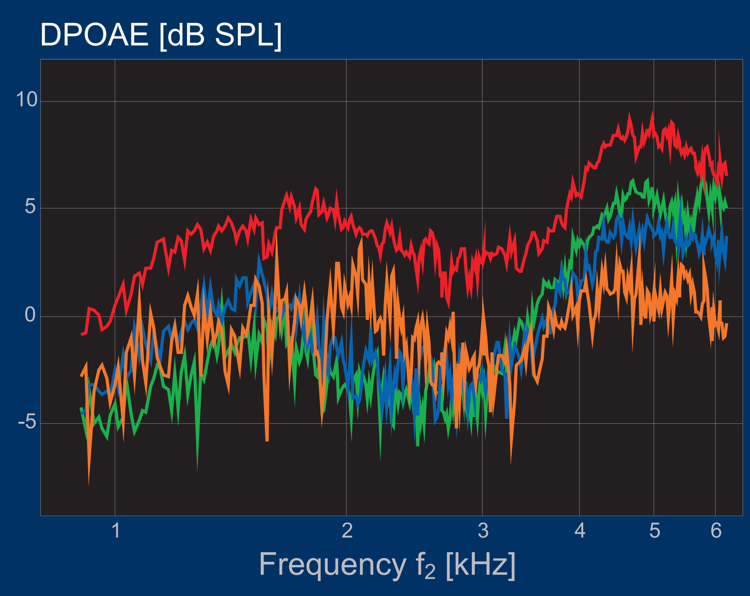
DPOAE mean of 12 subjects before and after rehearsal. The individual fine structures are smoothed out, when the data are averaged across subjects.

There was no significant DPOAE level shift after the rehearsal, nor threshold shift. This may be partly due to the fact that some time elapsed from cessation of the rehearsal untill the measurements could begin. Another explanation is that the measurements took quite some time, and the hearing therefore recovered before and/or during measurements.

The data from the musicians were compared with an age and sex balanced control group, and further compared with data for young normal-hearing students subdivided into the best and slightly elevated thresholds (above 10 dB HL), from [13].



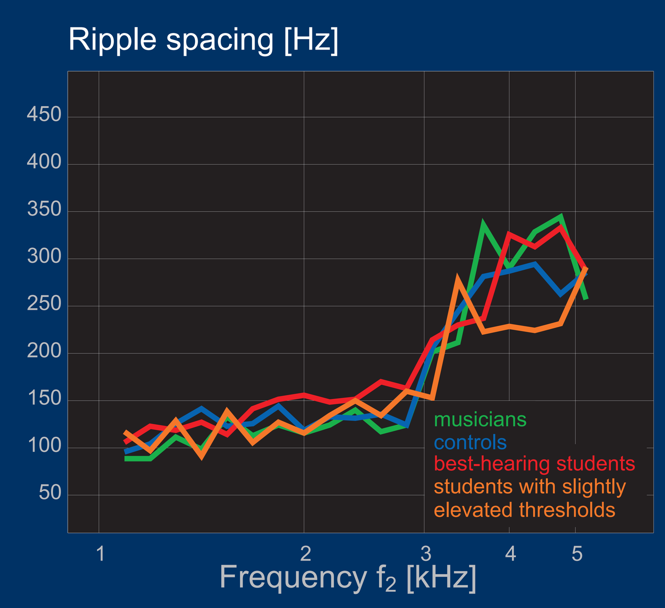
Musicians and the control group compare well, and have relatively good hearing for their age. The best hearing younger individuals (best-hearing students) have thresholds that compare well to the reference.



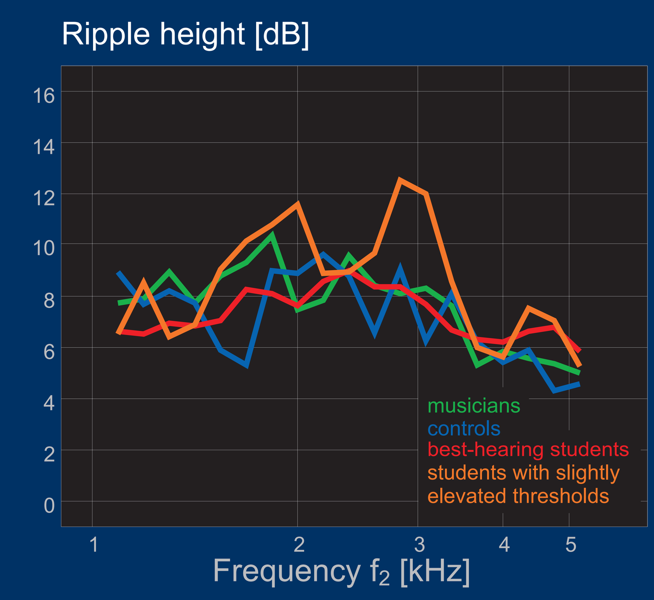
DPOAE data are also clearly better for best-hearing subjects. Musicians and control group compare well.

DPOAE fine structure

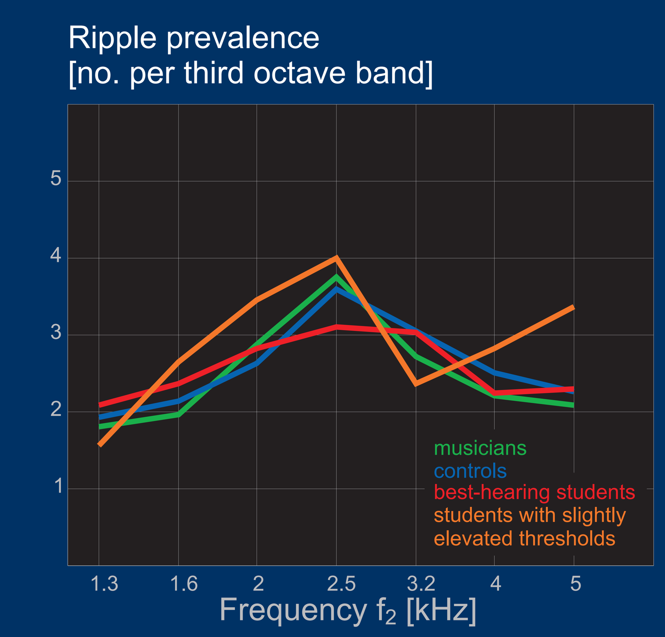
Fine structure characteristics were determined using the algorithm presented in [1], which determines:
- maxima and minima of fine structure ripples,
- ripple spacing as frequency difference between two minima,
- ripple height as level difference between maxima and mean of the two minima,
- number of ripples as ripples > 3 dB in height per 1/3 octave.



The ripple spacing is quite similar for the four groups, although on average sligthly more narrow for the group of students with sligthly elevated thresholds.



The ripple height is also quite similar for the four groups, although on average sligthly higher for the group of students with sligthly elevated thresholds.



The ripple prevalence is also quite similar for the four groups, although with a distinct bend around 3 kHz for the group of students with sligthly elevated thresholds.

Conclusion

There was no difference in the state of hearing for the musicians before and after rehearsal. The comparison between musicians and the control group, which were sex- and age-balanced to the musicians, revealed no significant difference in any measure. Both groups differed from the best-hearing students, both in overall DPOAE level and by some of the fine structure characteristics (spacing and height).

The difference in fine structure characteristics has no simple explanation. It may be that the early age-related deterioration of the hearing leads to more irregularities on the basilar membrane. These may generally affect the secondary (reflection) component for more frequencies than the place-specific component, thus the higher number of dips is related to higher order reflections.

The higher number of dips may however also be a consequence of the lower overall DPOAE level, which may result in a higher number of false dip detections.

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