

East Tennessee State University

From the Selected Works of Jacek Smurzynski

1998

Gap Detection Threshold in Ears with and without Spontaneous Otoacoustic Emissions

Jacek Smurzynski, *University of Basel*

Rudolf Probst, *University of Basel*



Available at: <https://works.bepress.com/jacek-smurzynski/55/>

Gap Detection Threshold in Ears with and without Spontaneous Otoacoustic Emissions

Jacek Smurzynski and Rudolf Probst

Department of Otorhinolaryngology, University of Basel, Kantonsspital, CH-4031 Basel, Switzerland

Abstract: Gap detection was measured for two groups of normally hearing young adults using broad-band noise stimuli. Group I consisted of subjects who exhibited both strong spontaneous and click-evoked otoacoustic emissions (SOAEs and CEOAEs). Group II included individuals with no SOAEs in either ear and weak CEOAEs. An adaptive 2IFC gap detection task was performed for the stimuli presented at either 10, 20, 30, or 50 dB SL. At 10 dB SL stimulus level, the ears in Group I exhibited greater intersubject variability and higher mean gap detection thresholds than those in Group II. At higher SLs, there were no differences between the results for the two groups. A short gap in the broad-band stimulus presented near the threshold is masked by SOAEs and emissions evoked by the stimulus.

INTRODUCTION

Several studies have accounted for the influence of strong otoacoustic emissions (OAEs) on psychoacoustic performance. For example, hearing threshold minima are associated with the presence of SOAEs and/or evoked OAEs (1). Moreover, subjects with SOAEs have better hearing sensitivity than those without SOAEs across the 1-6-kHz region, not just in the frequency regions of SOAEs (2). A study on intensity JNDs for subjects with and without strong OAEs failed to show different mean JNDs for intensity at 1 kHz (3). However, individuals with strong OAEs had less variance when performing the test at 60 dB SL and more variance for 20 dB SL stimuli than did individuals with weak OAEs.

It is still unclear if the overall status of a cochlea and middle ear producing strong OAEs has a generalized effect on peripheral auditory processing. Current data do not support the hypothesis that a "less active" OAE profile is indicative of subclinical damage to the cochlea. However, it is obvious that the ability of a subject to perform a psychoacoustic task may be influenced by the interaction between OAEs and test signals. The aim of this study was to determine if performance on the gap detection task varied as a function of OAE profile.

METHODS

Broad-band (0.1-12 kHz) stimuli were generated digitally and controlled by a Tucker-Davis system. The overall duration of the signal was 500 ms. The waveform was digitally shaped at onset and offset with 20-ms cosine-squared envelopes. Gaps shaped by 0.1-ms cosine-squared envelopes were placed at the stimulus midpoint. The standard (no-gap) stimulus was a continuous 500-ms signal. Signals were delivered to a tested ear through an ER3 insert earphone. Spontaneous OAEs were measured using an ER10A microphone according to the method described previously (4). A default nonlinear mode of the ILO88 system was used to collect CEOAE data.

Two groups of normally hearing young adults participated. One ear of each subject was targeted for testing. Group I included six women and five men ranging in age from 16 to 42 years (mean=27.4 yrs), one ear of which had at least two SOAEs (at least one SOAE level > -2 dB SPL) and CEOAEs with overall response levels >65th percentile of a laboratory normative database. The number of SOAEs ranged from 2 to 12 per ear. The SOAE frequencies varied from 0.6 to 6.9 kHz with the majority in the range from 1 to 3 kHz. The levels of SOAEs ranged from -2 to +17 dB SPL. Group II included three women and five men ranging in age from 16 to 39 years (mean=25.1 yrs) with no SOAEs in either ear detectable above the noise which averaged -15 dB SPL at 0.5 kHz and -20 dB SPL or lower above 1 kHz. The CEOAE levels of those subjects were <40th percentile of the laboratory database.

Each session started with two runs of an adaptive, two-down/one-up 2IFC procedure with feedback to determine the hearing threshold of the noise stimulus for each ear tested. Those results were averaged and used to adjust the stimulus level for the gap detection tasks that followed, also using the 2IFC procedure. The stimuli were presented at either 10, 20, 30, or 50 dB SL. The 2IFC procedure was run in sets of three to five blocks of 60 trials per block. Each gap detection threshold reported is the mean of the estimates from ten runs per subject per each signal level. Order of presentation was randomized across subjects.

RESULTS

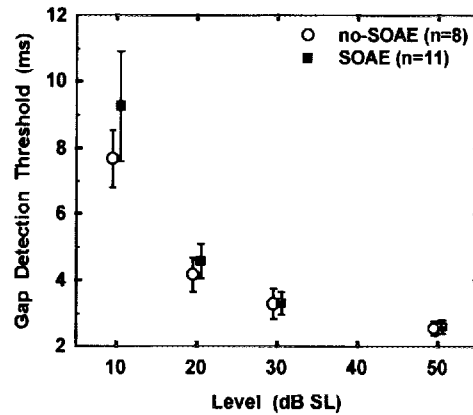


FIGURE 1. Mean gap detection threshold versus the stimulus level (filled squares: Group I; open circles: Group II).

The two groups had almost identical mean values of hearing thresholds for the noise stimulus. The mean gap detection thresholds are shown in Fig. 1. The error bars represent ± 1 s.d. of the grouped data. The two groups differed significantly from one another for the 10 dB SL stimulus. The ears in Group I had higher mean gap detection thresholds than those of Group II (t-test; $p < 0.03$) mainly due to results from the subjects with multiple SOAEs. Four out of five subjects who exhibited at least six SOAEs had the highest thresholds within Group I. The highest value of the gap detection threshold (11.8 ms) was obtained for the subject with the greatest number of SOAEs (i.e., 12) and with the highest SOAE level (up to +17 dB SPL). Three out of six subjects with two to five SOAEs had gap detection thresholds below the mean value of Group II. For the 20 dB SL stimulus, the difference between the means for the two groups was not statistically significant ($p = 0.12$). At higher SLs (30 and 50 dB), both groups had almost identical mean results and the threshold values are consistent with those found in the literature (5). The two groups had very similar intersubject variability for the 20, 30, and 50 dB SL stimuli.

DISCUSSION AND CONCLUSIONS

The results showed that the gap detection threshold decreased with increasing stimulus level – in good agreement with other studies of gap detection for wide-band signals (5). The most significant influence of stimulus level was observed when stimuli were close to the hearing threshold. This is consistent with an account that considers the fluctuations in the noise. As the noise level decreases, the relative importance of the fluctuations increases, and the change in power produced by the gap becomes more difficult to detect. This effect is expected to be even stronger as the noise bandwidth is decreased.

Differences between the gap detection thresholds for the two groups of subjects, at a presentation level near the hearing threshold suggest that a short gap is masked by SOAEs and OAEs that are evoked by the stimulus. This effect is stronger for ears with multiple and robust SOAEs. For higher stimulus levels, SOAEs are suppressed by the test signal. The gap detection threshold is shorter than the time needed to recover from suppression (6).

ACKNOWLEDGEMENTS

Work supported by a grant from Swiss National Science Foundation (project No. 3200-042241.94/1).

REFERENCES

1. Smurzynski, J. and Probst, R., *Diversity in Auditory Mechanics*, Singapore: World Scientific, 1997, pp. 270–276.
2. McFadden, D. and Mishra, R., *Hearing Research* **71**, 208–213 (1993).
3. Probst, R. and Harris, F.P., *Journal Acoustical Society of America* **100**, 504–510 (1996).
4. Smurzynski, J. and Probst, R., *Hearing Research* **115**, 197–205 (1998).
5. Buus, S. and Florentine, M., *Time resolution in auditory systems*, New York: Springer-Verlag, 1985, pp. 159–179.
6. Murphy, W.J., Talmadge, C.L., Tubis, A. and Long, G.R., *Journal Acoustical Society of America* **97**, 3702–3710 (1995).