



ABR and Behavioral Off-frequency Masking Patterns

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Introduction

Off-frequency masking (OFM) is the simultaneous masking of a signal by an off-frequency tone or noise. The purpose of the current study is three-fold: (1) To determine the effect of off-frequency remote masking on the characteristics of the ABR waveform, (2) To quantify differences between electrophysiologic and psychophysical off-frequency remote masking effects and (3) To take the first steps in developing a method to measure electrophysiologic tuning curves. Psychophysical tuning curves can provide an index of frequency selectivity. This is valuable information for not only laboratory study but also in the clinical setting. Unfortunately, there is essentially no viable measures of frequency selectivity in the clinical arena. Electrophysiologic tuning curves, if they can be developed, could be an attractive procedure in that it would allow an objective measure of frequency selectivity and also provide insight to the physiologic integrity of the auditory pathway.

Methods

Subjects

- 11 subjects with bilateral normal hearing over the age of 18.
- Pure tone thresholds were 25 dB HL or better bilaterally at the octave frequencies of 250-8000 Hz using ER-3A insert earphones with no more than 15 dB interaural difference.
- Normal type A tympanograms bilaterally on the day of testing (Jergers, 1970).
- Normal CAP as determined by Dichotic Digits (Musiek, 1983) at 50 dB SL with 90% correct bilaterally.
- No history of learning or reading disability, auditory processing disorders, neurological problems or otologic problems.

Stimuli

- 2000 Hz tonal stimuli (tone burst envelope comprises a rise and fall time of 1 ms each and a plateau of 0 ms) was presented through ER-3A insert earphones at a repetition rate of 17.7 clicks/second and threshold was measured for each condition, behaviorally and electrophysiologically.
- Masking noise consisted of narrowband noise produced by the GSI 61 and routed into the Nicolet Spirit centered around 2 kHz, 1.5 kHz and 3 kHz with a minimum 1/3rd octave band roll-off.
- 2000 accepted trials will be collected for each run with no more than 200 rejections.

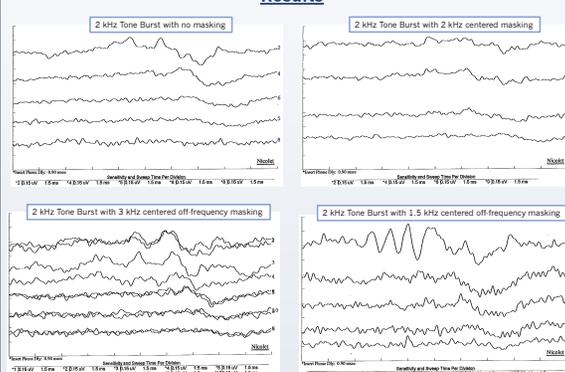
Recording Parameters

- Electrodes were placed at Cz (active electrode), A1 or A2 (reference) and A2 or A1 (ground). Impedances remained below 5 kOhms for all electrodes during testing. There was less than 1 kOhms difference between electrodes.
- Responses were online filtered at 30 Hz to 3 kHz.

Procedures

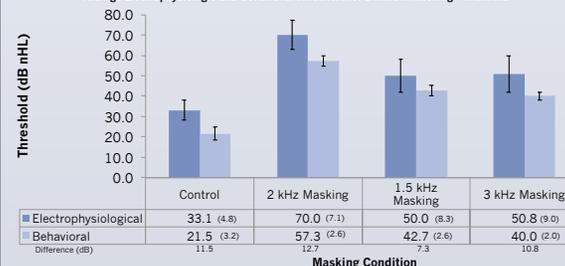
- Test ear was pseudo-randomized such that an equal number of right and left ears were tested.
- All waveforms were replicated.
- ABR responses were recorded for each recording condition. Threshold was determined as the last level with a readable waveform. The following was recorded:
 - Absolute wave latencies for ABR wave I, III and V
 - Interpeak latencies between ABR wave I, III and V
 - Amplitude measurements (peak to trough) of the ABR wave V

Results



The results of a repeated measures ANOVA demonstrate a significant effect of masking frequency and condition (electrophysiologic vs. behavioral) with no significant effect of ear of presentation and no significant interactions. A pairwise comparison revealed a significant difference between all conditions except between the off-frequency masking conditions (1.5 kHz and 3 kHz centered masking). A strong correlation was observed between electrophysiologic threshold and behavioral threshold ($r=0.988$). The average difference between electrophysiologic and behavioral threshold was 10 dB, with slightly greater differences observed for the control condition with no masking and the 2 kHz masking condition as compared to the OFM conditions.

Average Electrophysiologic and Behavioral Threshold for Different Masking Conditions



Conclusions

1. The ABR can be utilized to provide reliable and interpretable responses for the off frequency research paradigm as described.
2. The trends of masking effects on the waveform morphology and thresholds of the ABR are consistent with what would be expected based on psychophysical data and related ABR investigations into this topic
3. There is a strong correlation between behavioral and electrophysiologic findings for this off-frequency paradigm.
4. The electrophysiologic thresholds across the frequencies tested are slightly higher than behavioral thresholds. This differential is typical for electrophysiologic and behavioral comparisons.

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Abstract

Off-frequency masking (OFM) is the simultaneous masking of a signal by an off-frequency tone or noise. The purpose of this study, by using OFM, was a first step towards developing a method for measurement of electrophysiologic tuning curves employing ABR. OFM thresholds were established using psychophysical and ABR approaches for 2000 Hz tone bursts (2.0-2 cycles) at a repetition rate of 17.7 clicks per second. Four conditions consisted of an unmasked condition and three masked conditions with masking noise consisting of 1/3 octave band narrowband noise centered around 2000 Hz, 3000 Hz and 1500 Hz at 60 dB SPL. Threshold was measured by varying stimulus intensity while the masker remained stationary. In general, the shift due to masking was comparable between electrophysiologic measures and psychophysical measures, with the average difference being about 10 dB. Contour of the psychophysical and electrophysiologic tuning curves are similar, which corroborate results from Klein and Mills (1981), showing that it is possible to obtain reliable physiological tuning curves using waves I and V of the ABR in humans. Possible clinical applications are to provide an objective, ecological measure of frequency selectivity.