THE STACKED ABR

A Successful Small Acoustic Tumor Screening Method

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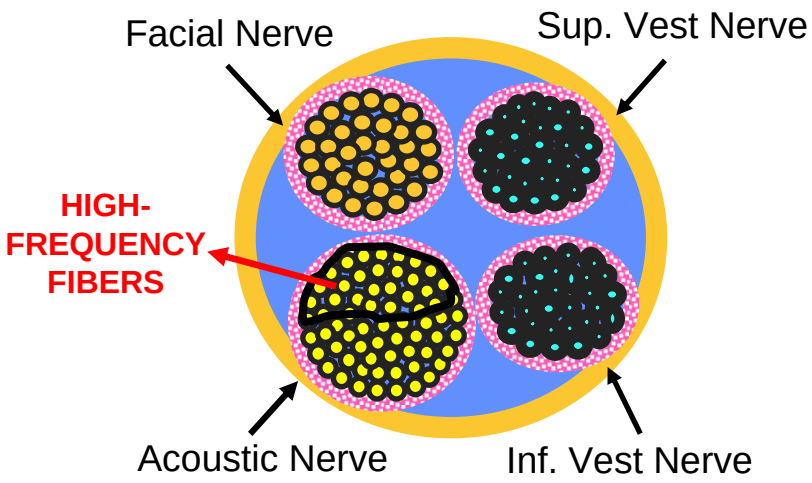
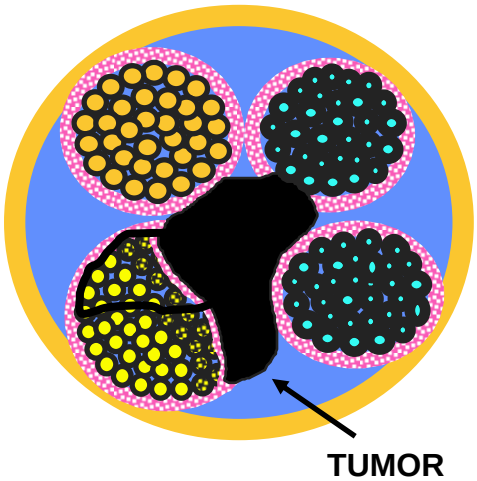
Standard ABR

Cross-section of Internal Auditory Canal

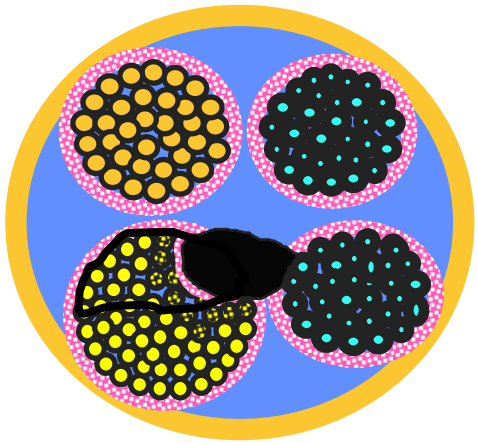


The wave V latency used in the standard ABR IT5 and I-V delay measures is dominated by neural activity from the high-frequency regions of the cochlea. Thus, unless the tumor affects these high-frequency fibers sufficiently, standard ABR latencies will be normal.

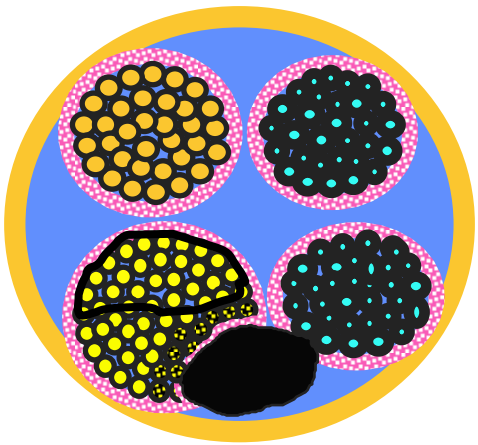
Large Tumor
Abnormal Standard ABR



Small Tumor
Abnormal Standard ABR



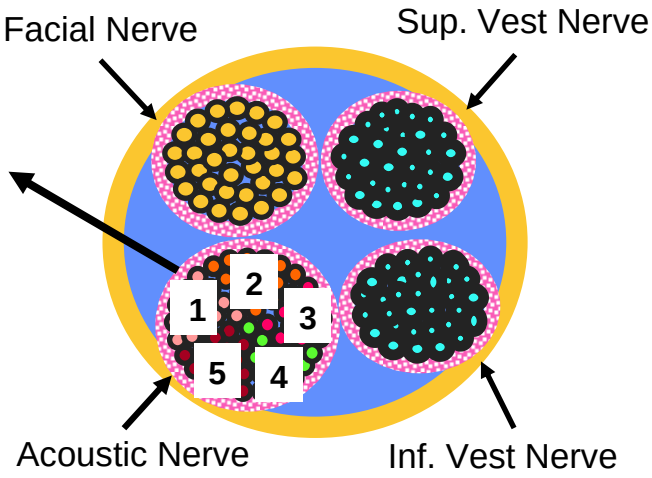
Small Tumor
Normal Standard ABR



Stacked ABR

Total Neural Response = Sum of Activity from five frequency regions

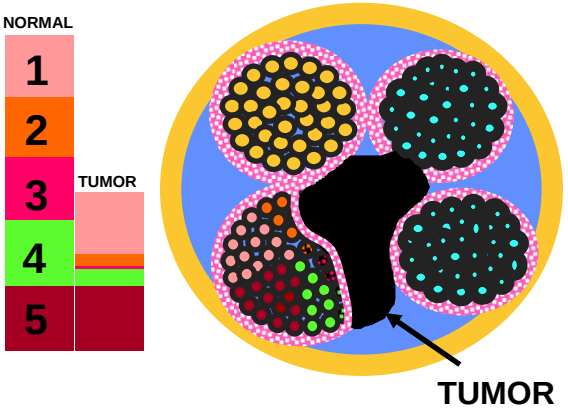
Cross-section of the Internal Auditory Canal



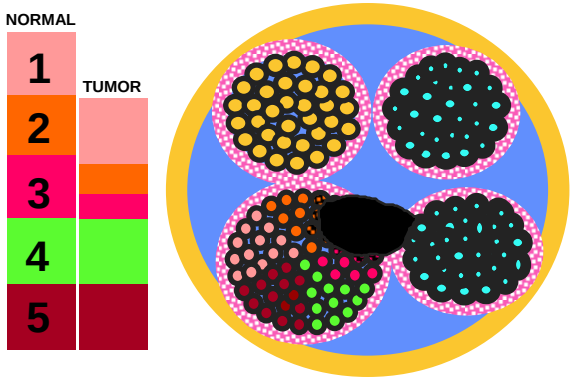
Required for Successful Detection of Small Acoustic Tumors

- **An auditory signal that will stimulate essentially all frequency regions of the cochlea (i.e., an appropriate click)**
- **A method for separating out responses from the different frequency regions of the cochlea (i.e., derived-band ABR technique)**
- **A procedure of adding the responses together to approximate total neural activity (i.e., stacking method)**

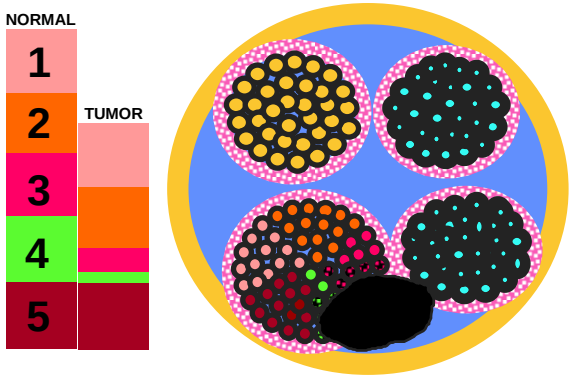
Large Tumor **Abnormal** Stacked ABR



Small Tumor **Abnormal** Stacked ABR

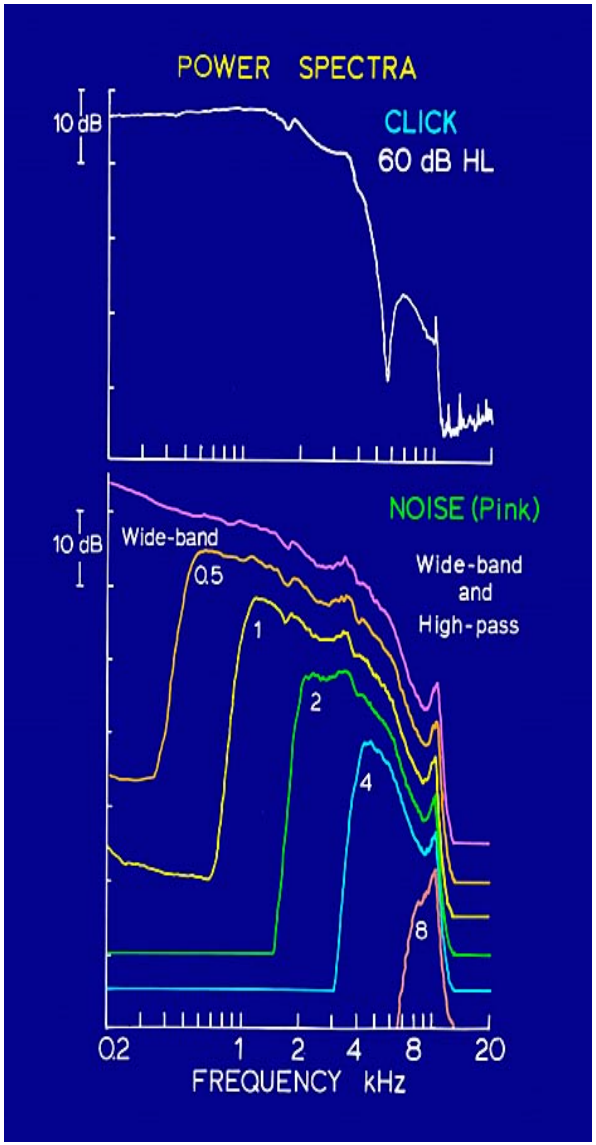


Small Tumor **Abnormal** Stacked ABR

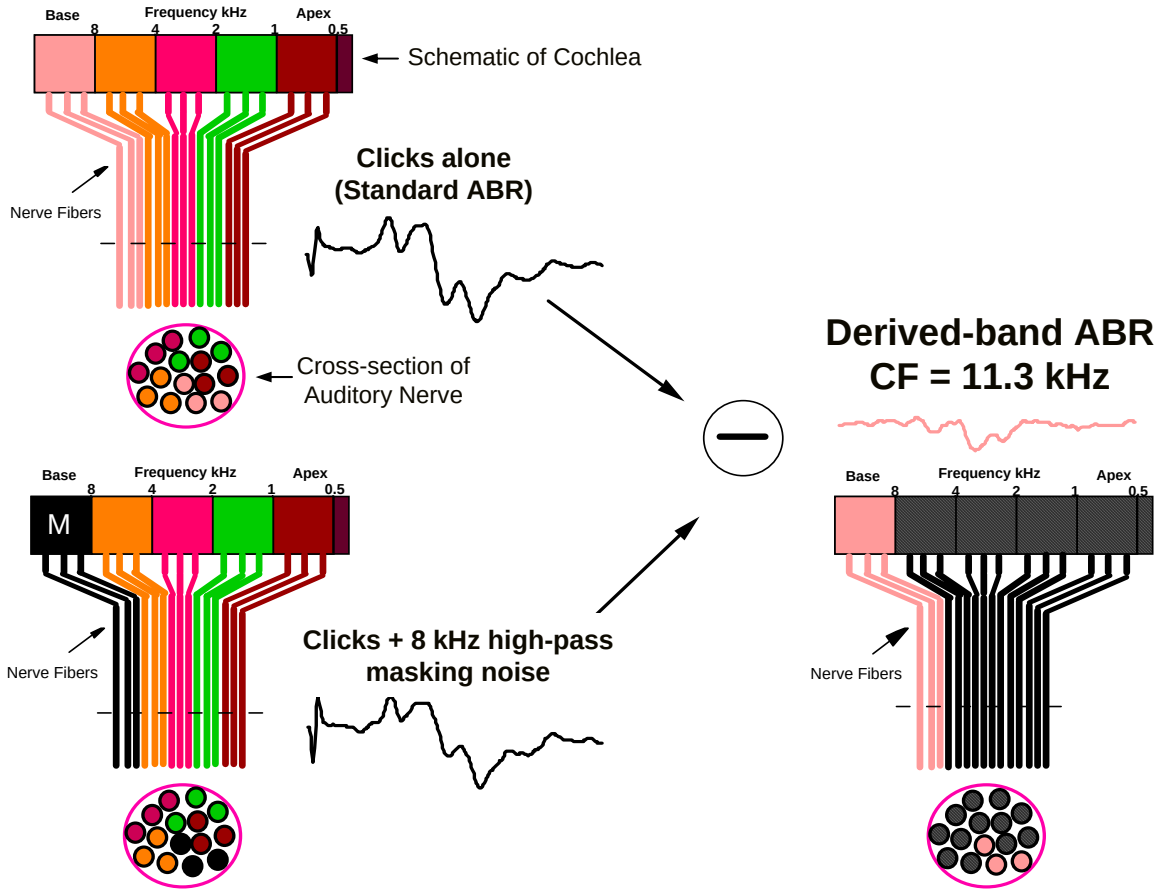


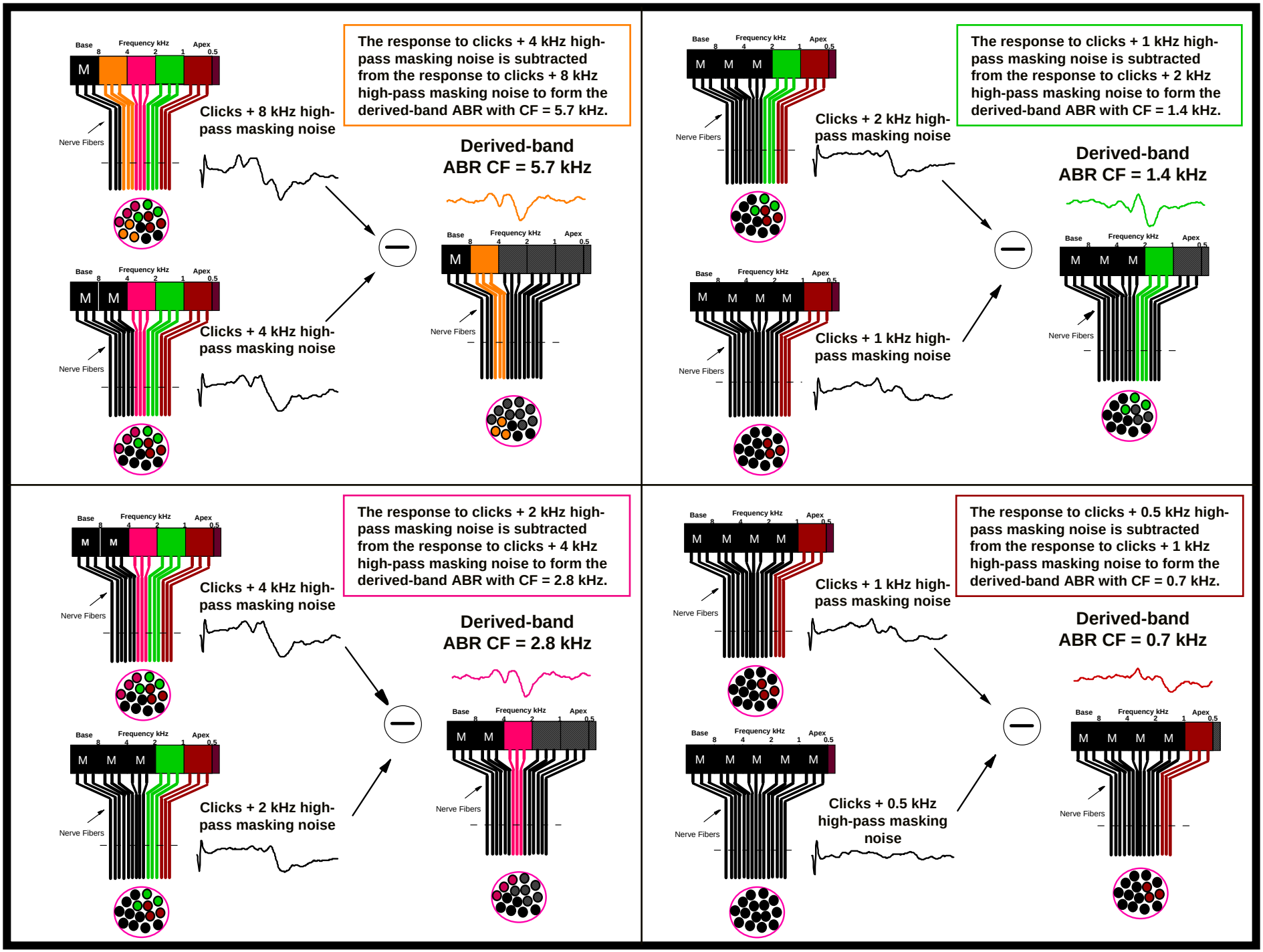
Standard ABR missed this tumor!

The Derived-band Technique



Click stimuli are delivered in the presence of high-pass masking noise. The cutoff frequency of the high-pass noise is lowered from one run to the next. This process masks progressively lower frequency areas of the cochlea. Subtracting the response for one run from the previous one forms a derived-band response. Here, the response to clicks + 8 kHz high-pass masking noise is subtracted from the response to clicks alone to form the derived-band ABR with center frequency (CF) = 11.3 kHz.





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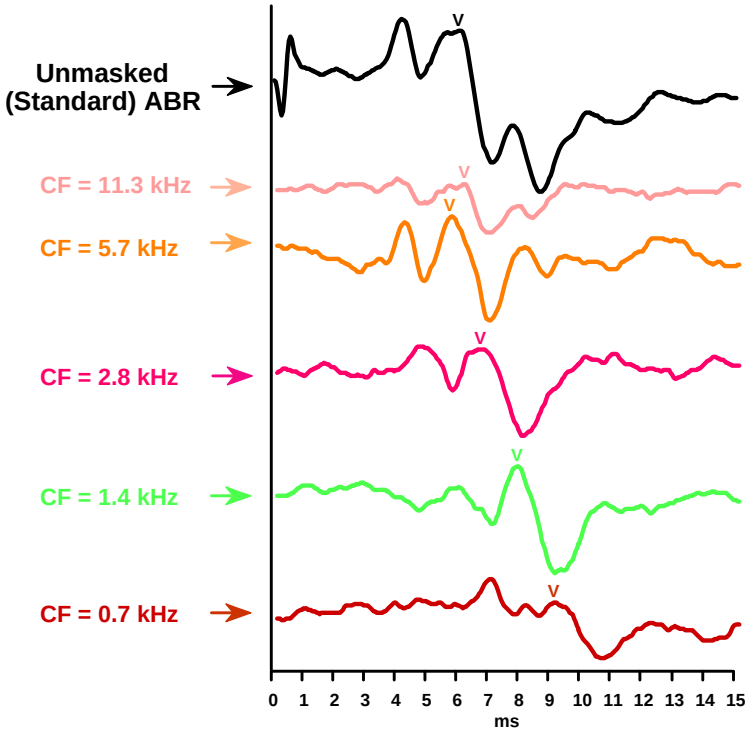
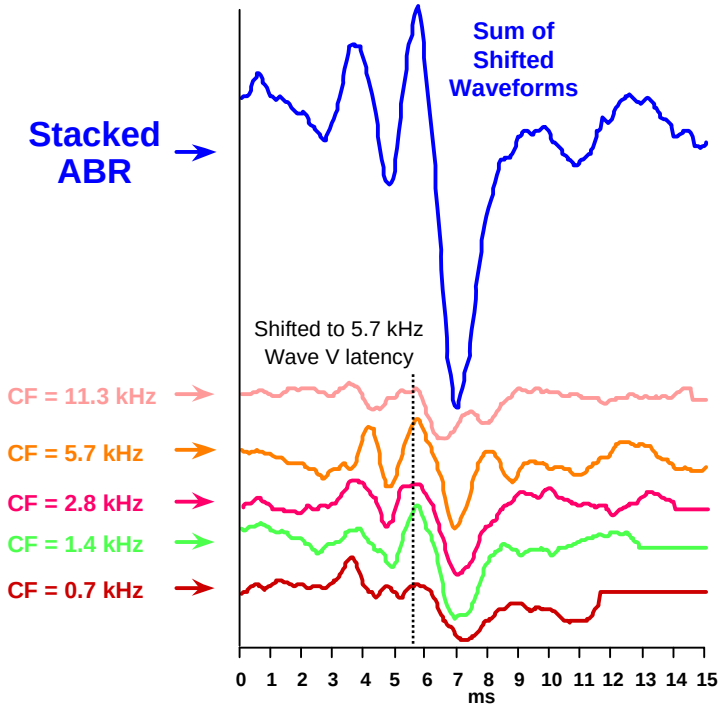
The Stacking Method





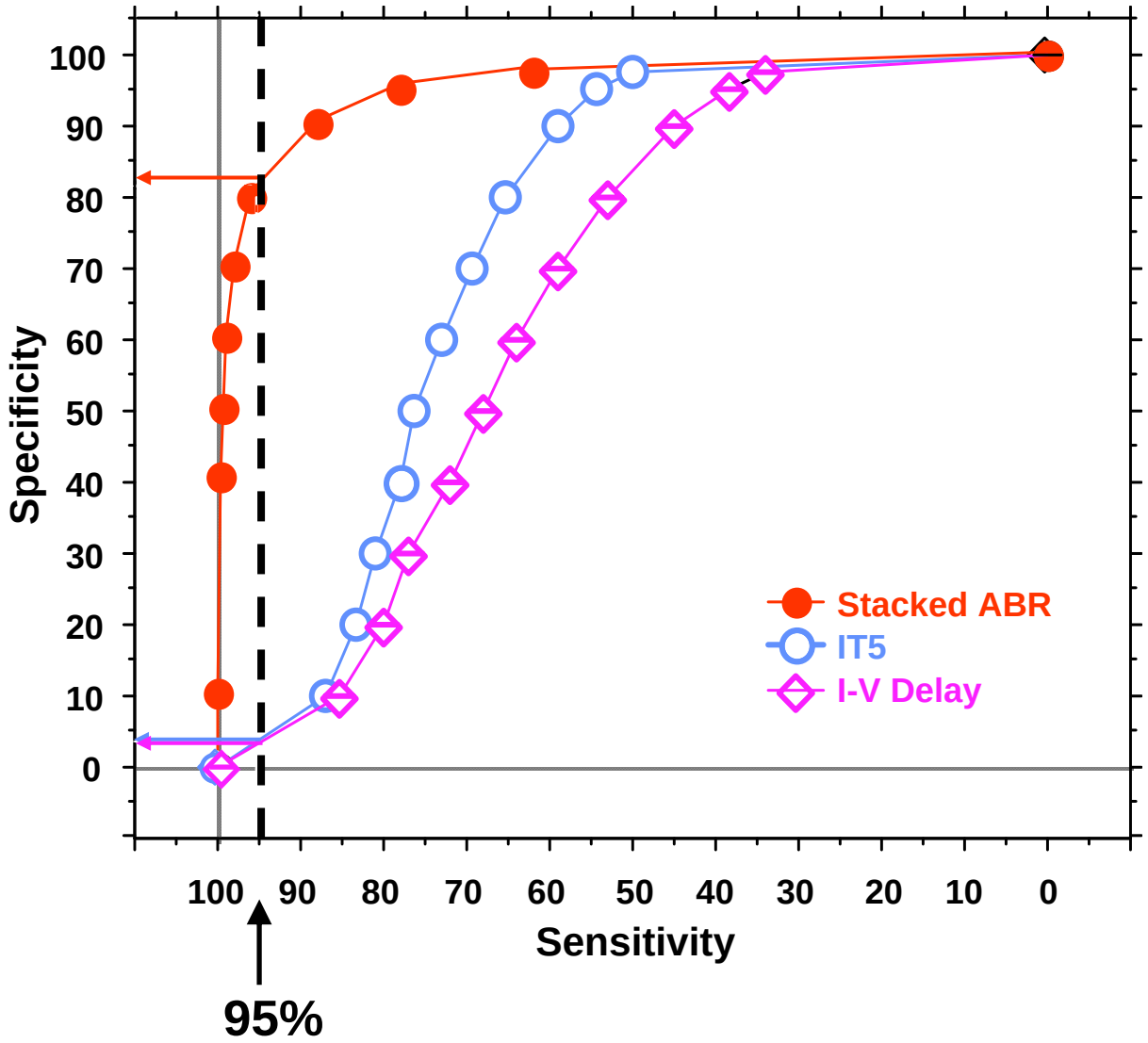
Derived-band ABR Summary

- Neural contributions from different frequency regions of the cochlea can be obtained using the derived-band ABR method.
- Derived-band ABRs represent activity from more specific frequency regions than moderate-to-high level toneburst-evoked ABRs.

Stacked ABR Summary

- The Stacked ABR is formed by temporally aligning wave V of the derived-band ABRs and then summing the responses.
- Aligning the derived-band ABRs eliminates phase cancellation of lower frequency activity. Thus, the Stacked ABR amplitude reflects activity from all frequency regions of the cochlea, not just the high frequencies.
- Reduction of <u>any</u> neural activity due to a tumor, even a small tumor, will result in a reduction of the Stacked ABR amplitude.

Standard vs Stacked ABR Measures



For <u>95% sensitivity</u>

(that is, for correct identification of 95 out of every 100 small tumors):

The IT5 and I-V Delay measures have less than <u>5% specificity</u>

(that is, the IT5 and I-V Delay correctly identify less than 5 out of every 100 non-tumor patients),

But the Stacked ABR has <u>83% specificity</u>

(that is, the Stacked ABR correctly identifies 83 out of every 100 non-tumor patients)!

CONCLUSION

The Stacked ABR appears to have better sensitivity and specificity than the Standard ABR for small (≤ 1 cm) acoustic tumors.

In other words, the Stacked ABR is better at :

1. detecting small tumors, and
2. decreasing the number of misdiagnosed non-tumor patients (i.e., decreasing the number of false-positives referred for MRI).

ABR SCREENING PROTOCOL FOR ACOUSTIC TUMORS