



# Dynamic aspects of noise reduction in hearing aids

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## Noise reduction (NR) in hearing aids

### Why?

- Increase comfort (ease of listening) in noisy situations
- Increase speech intelligibility in noise

### How?

- Estimate speech and noise (modulation characteristics)
- Determine SNR in a number of compression channels (8-24)
- Adjust the gain based on certain rules associated with the SNR

### Effect?

- Long-term average measurements (Hoetink, Körössy, and Dreschler. *Int J Audiol*, 48, 2009, 444-455)
- Evaluations of NR:s point towards benefit in comfort (ease of listening), but seldom in speech intelligibility

## Long-term average gain measurements

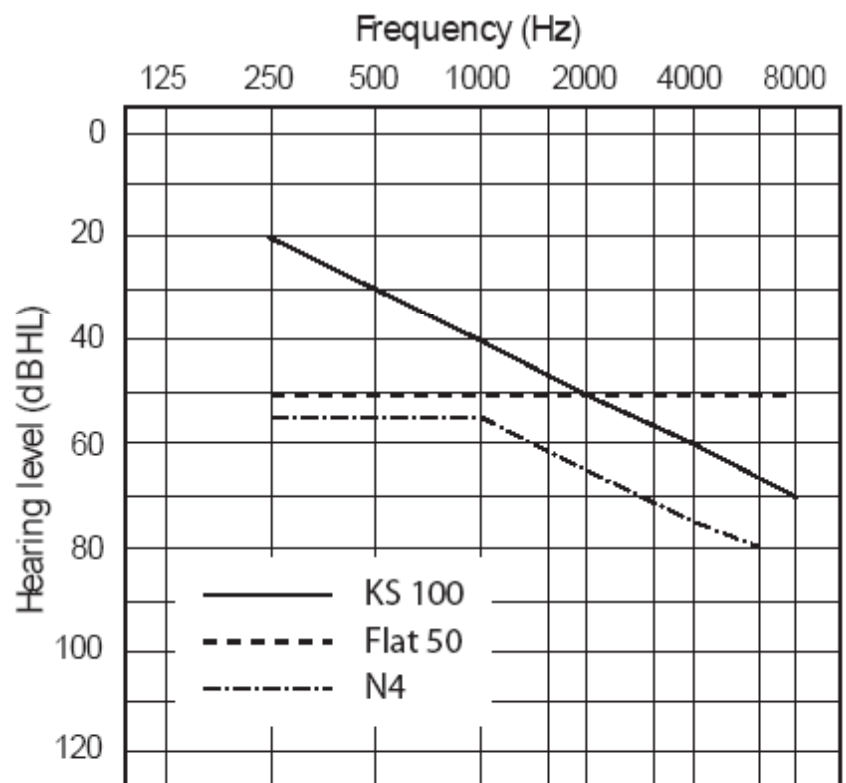
- Hearing aids
  - 12 modern HA:s
  - Mic, OMNI
  - MPO, MAXIMAL
  - Expansion, OFF
  - VC, OFF
  - Feedback reduction, OFF
  - Other sig. proc., OFF
- Programming
  - default prescription
- Equipment
  - Equinox HIT440, IA
  - TBS25 test box, IA
  - 711 coupler, GRAS
  - Mic (ref./meas.), GRAS
- Measurements
  - Pre-conditioning  
30 seconds
  - Long-term average  
30 seconds

"Classification of steady state gain reduction produced by amplitude modulation based noise reduction in digital hearing aids" by Hoetink AE, Körössy L, and Dreschler WA. Int J Audiol, 48, 2009, 444-455.

## Method

- Measurement signals
  - ISTS (ISMADHA draft)
  - ICRA1 (stationary speech-weighted noise)
- Variables
  - SNR in the input signal (8 different)
    - "Speech", +6 dB, +3 dB, 0 dB, -3 dB, -6 dB, -9 dB, -12 dB
  - Sound pressure level (fixed speech level)
    - 62 and 75 dB SPL (ANSI S3.5)
  - Audiogram (3 different)
    - KS100, Flat50, N4

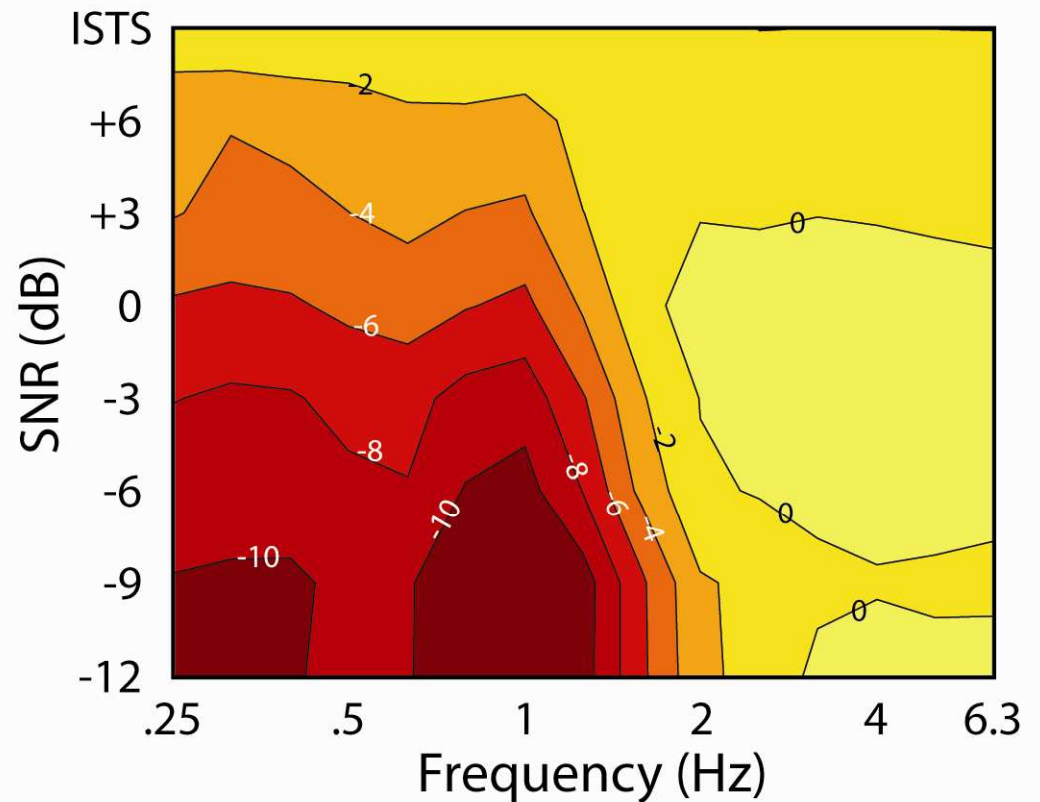
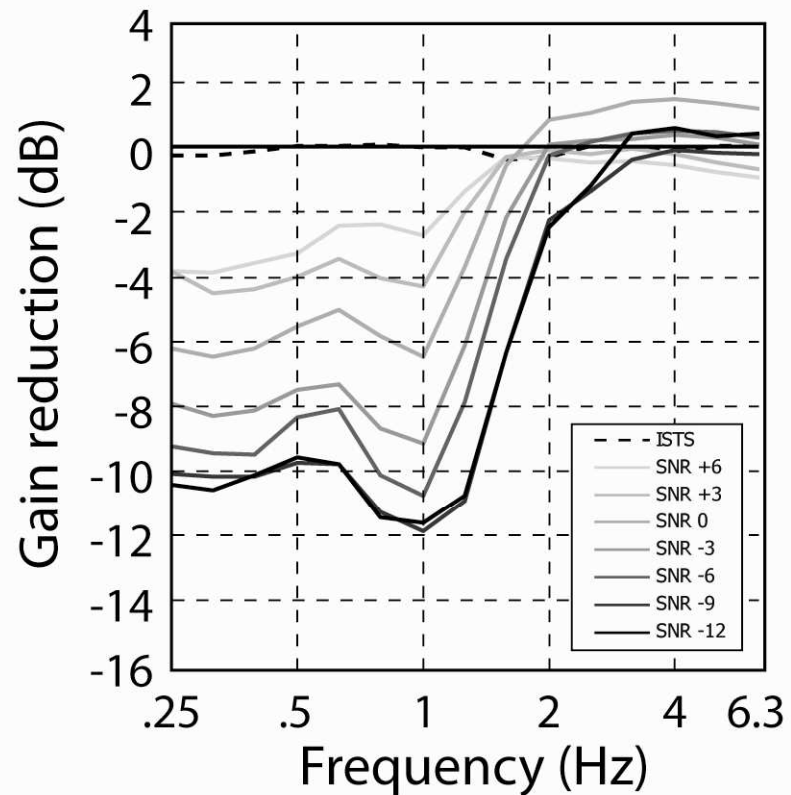
# Audiogram

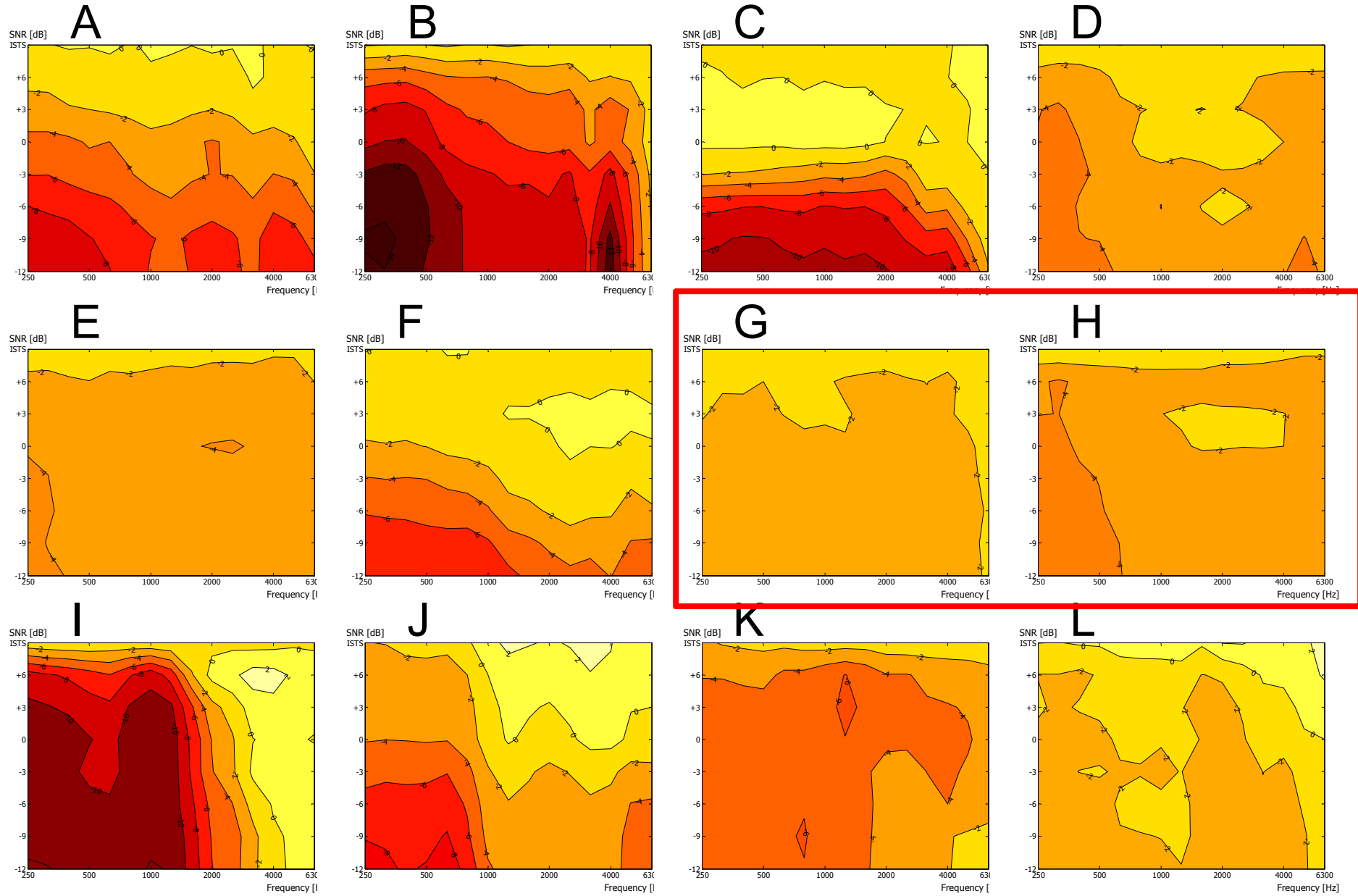


## Gain reduction

Gain reduction = ON - OFF

Reduction contours



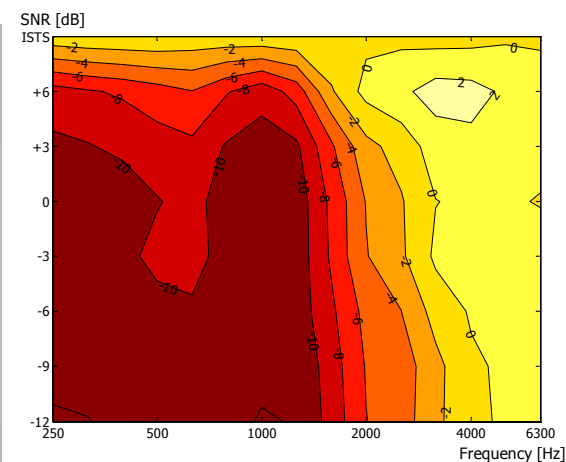
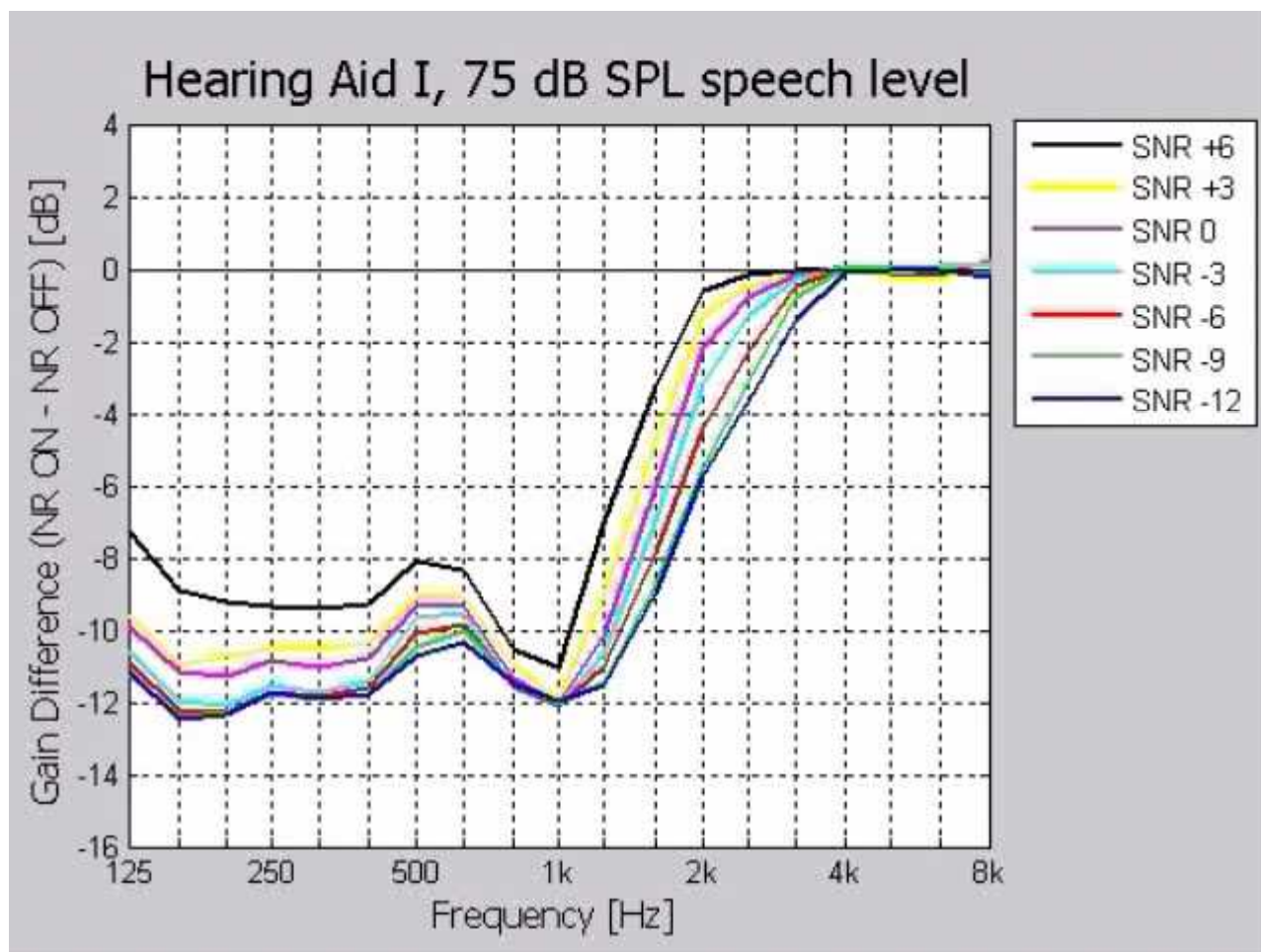


## Short-term average gain reduction – Method

- Hearing aid
  - 12 modern HA:s
  - Mic, OMNI
  - MPO, MAXIMAL
  - Expansion, OFF
  - VC, OFF
  - Feedback reduction, OFF
  - Other sig. proc., OFF
- Programming
  - default prescription
- Equipment
  - Recordings sound card
  - MATLAB processing
  - TBS25 test box, IA
  - 711 coupler, GRAS
  - Mic (ref./meas.), GRAS
- Measurements
  - Pre-conditioning: 30 s
  - Short-term average (1/3-oct): 125 ms
  - Updated every 40 ms
  - Hagerman sentences in ICRA1 noise
  - KS100 audiogram



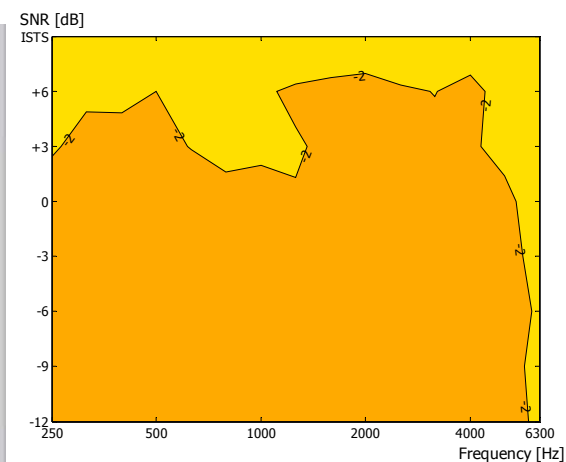
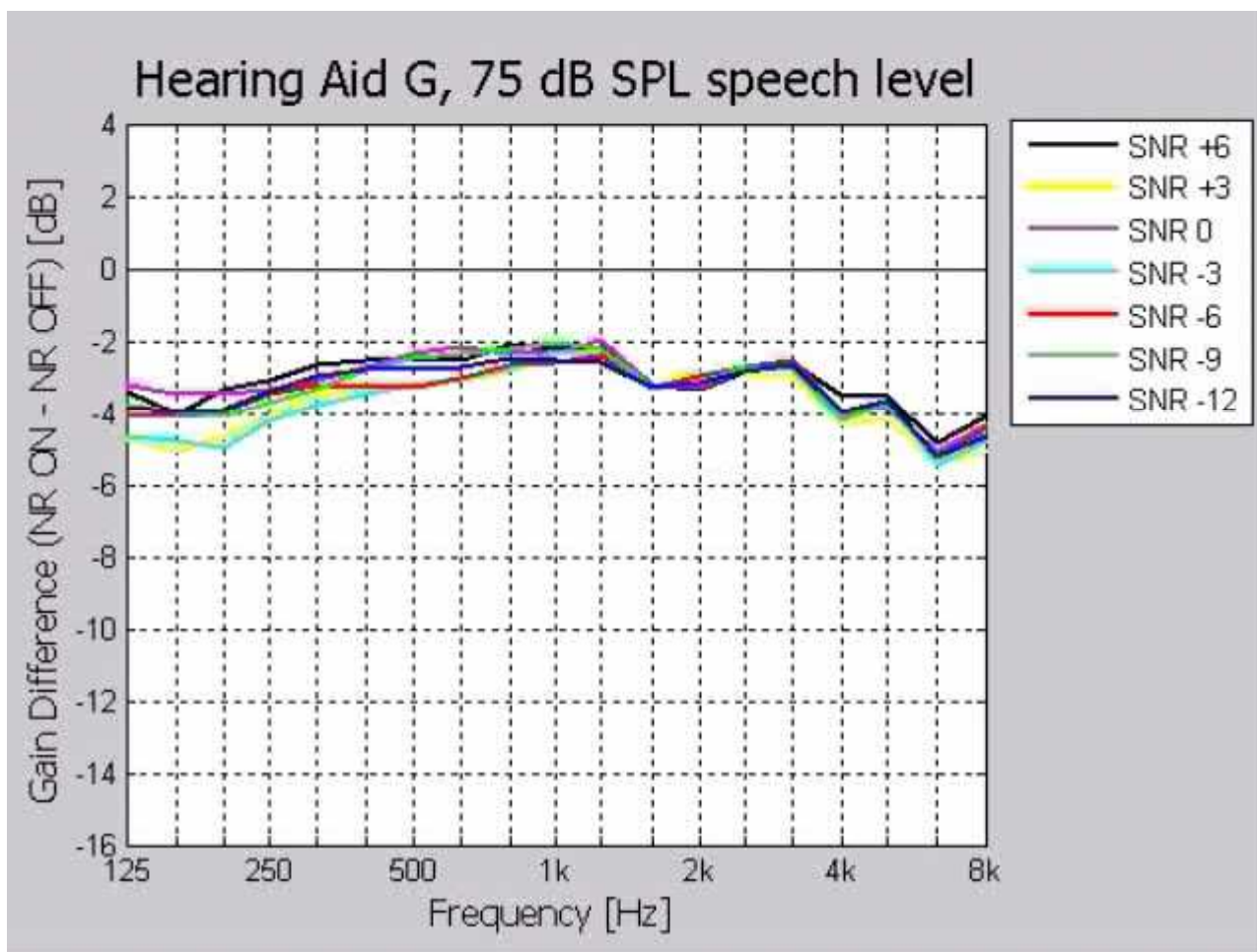
## Results



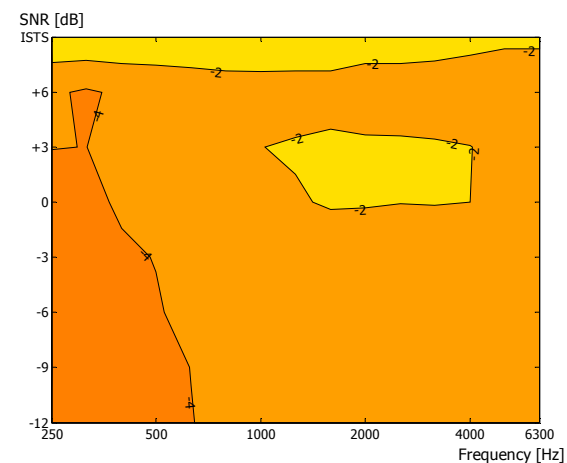
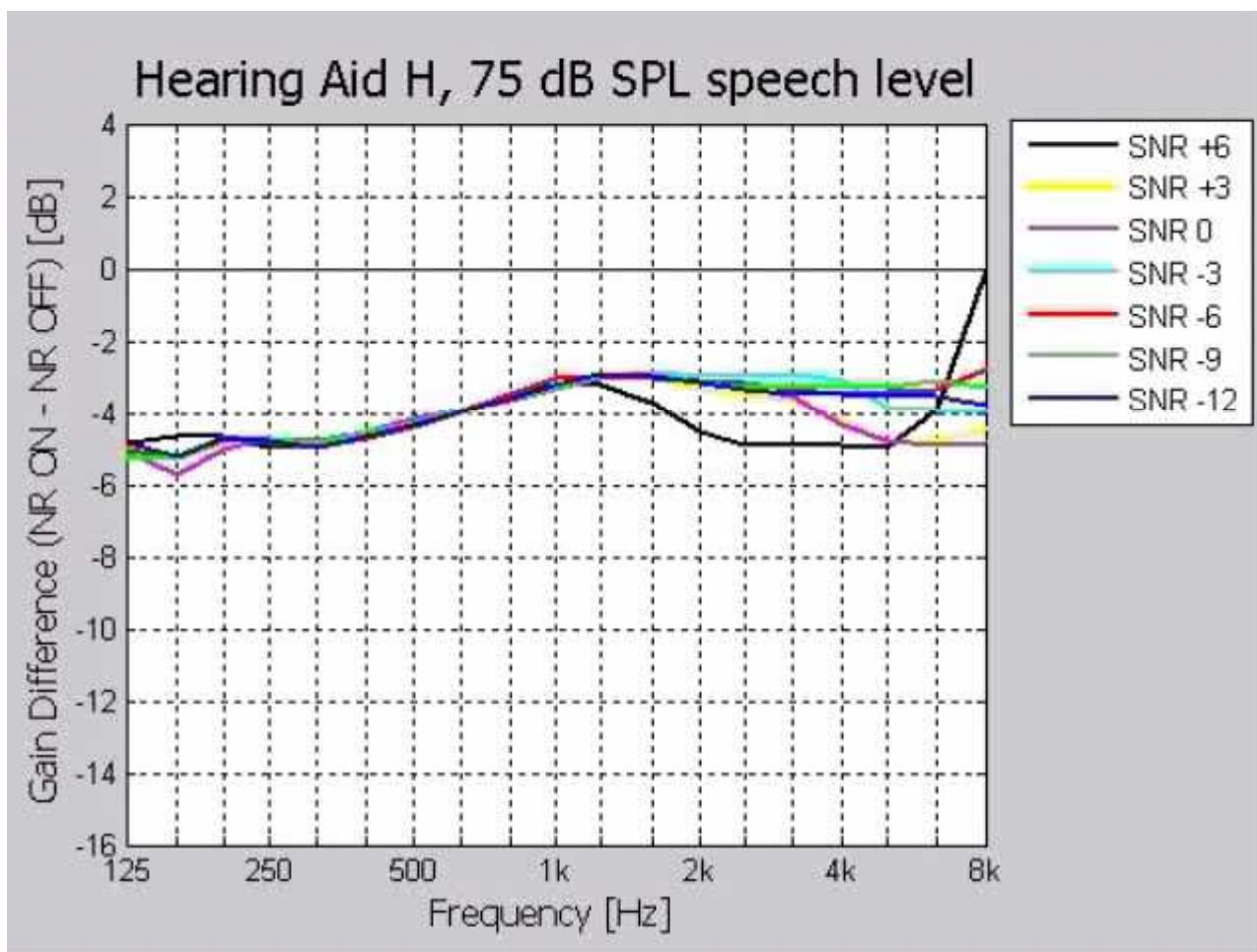
14 measurements  
(7 SNR, NR  
on/off) in the  
same figure.

We will listen to  
the speech signal  
without noise.

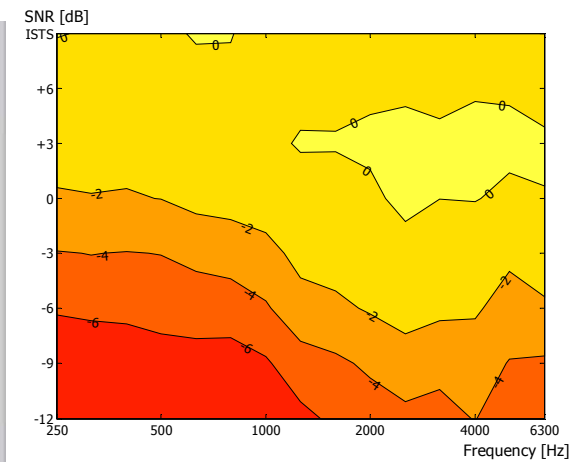
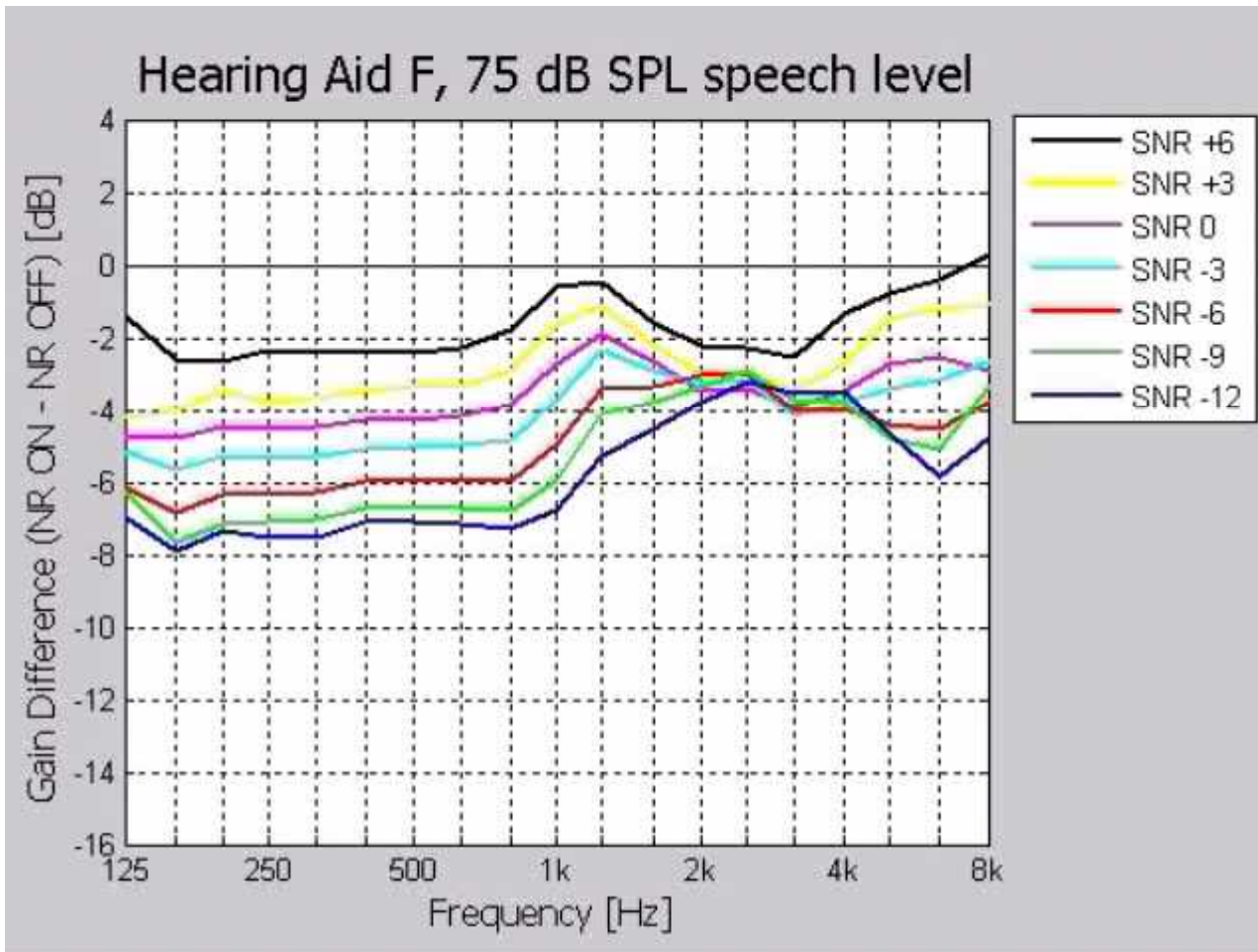
## Results



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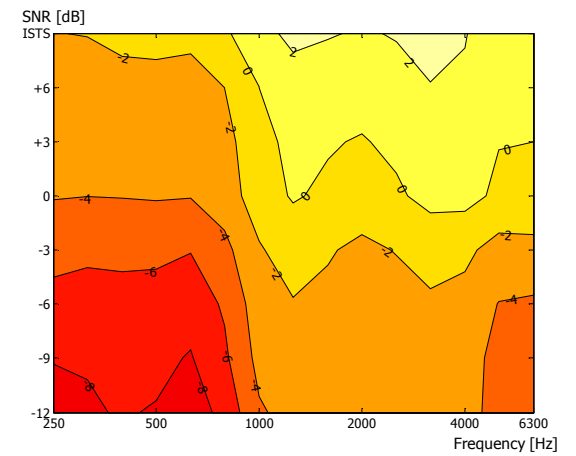
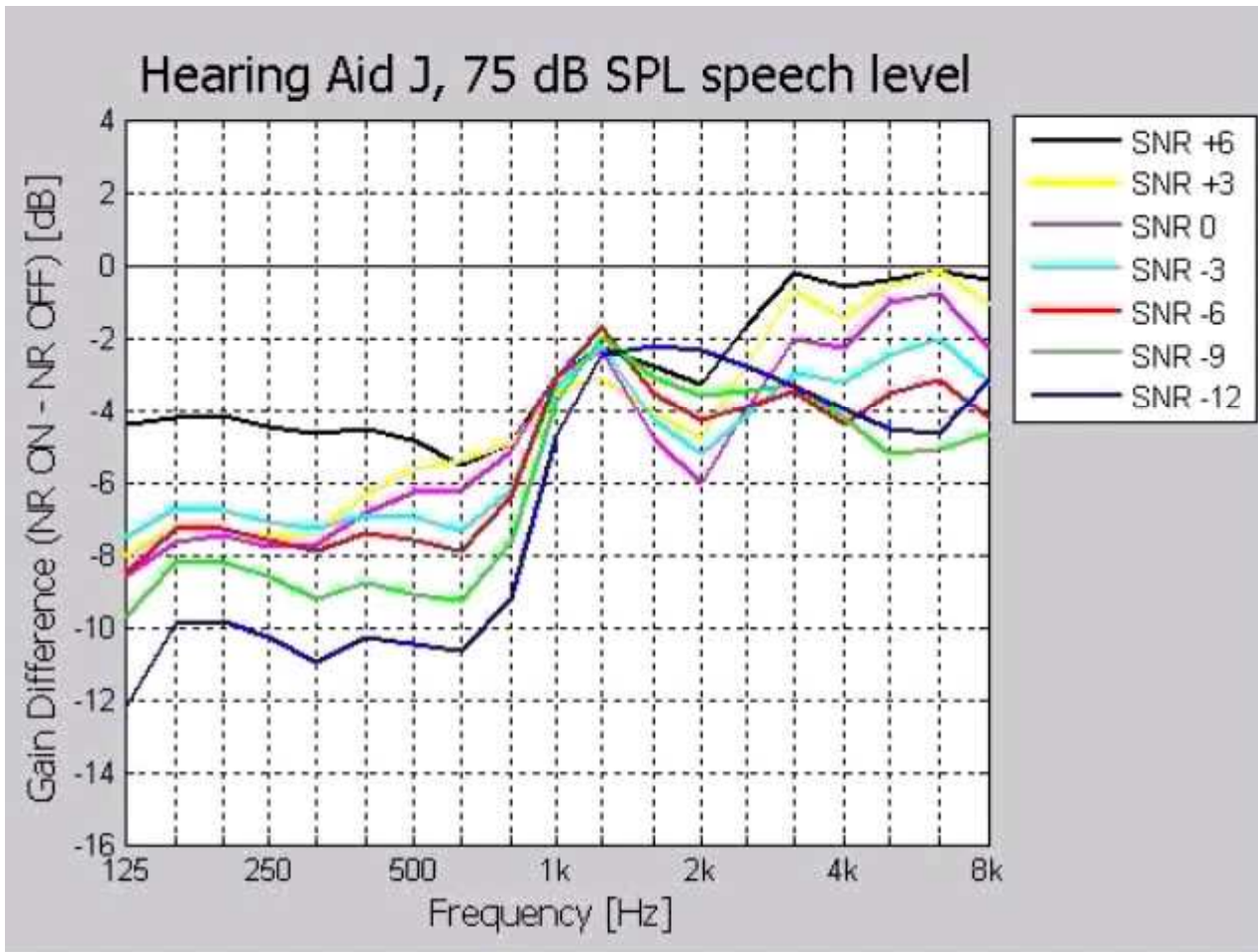


## Results





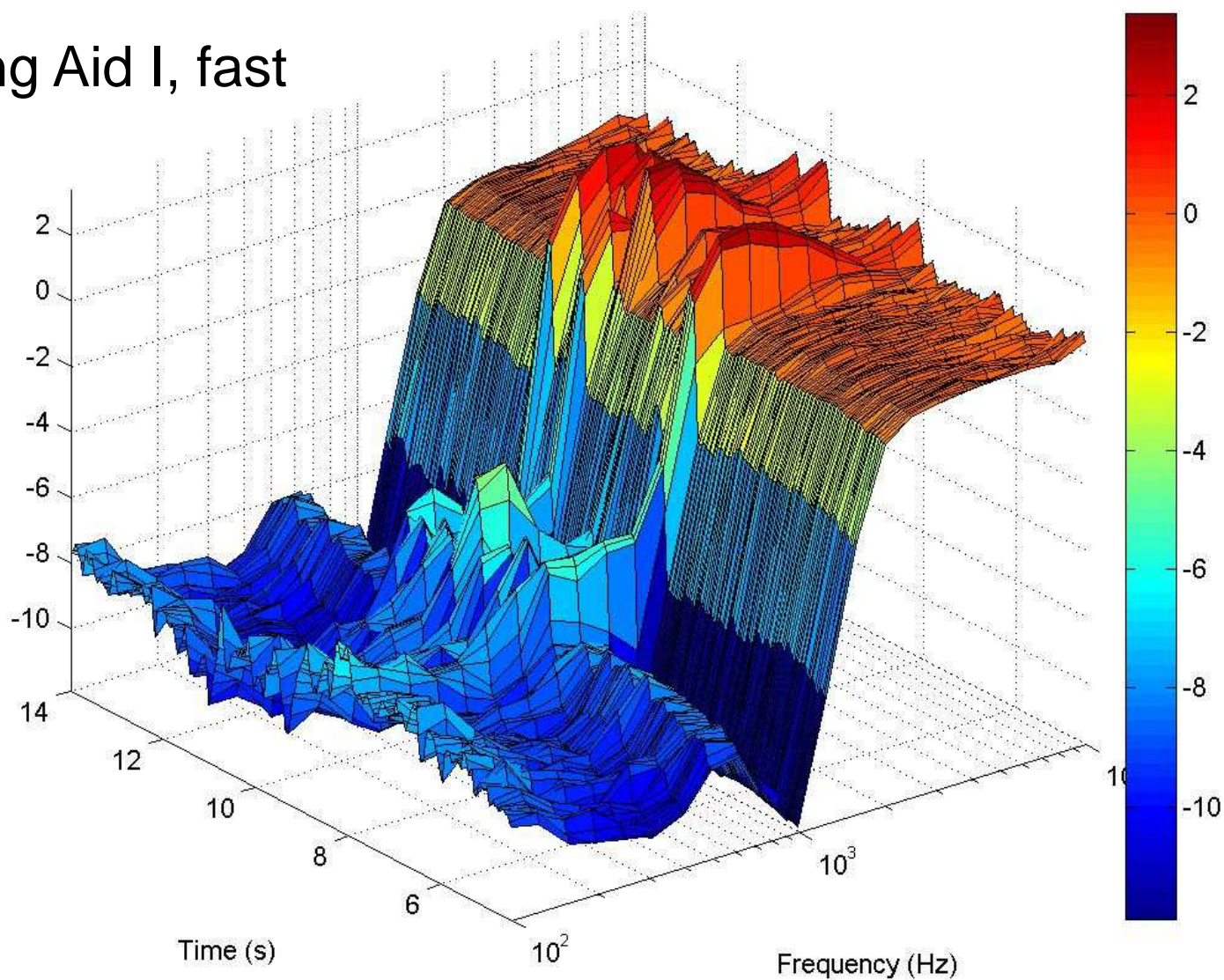
## Results





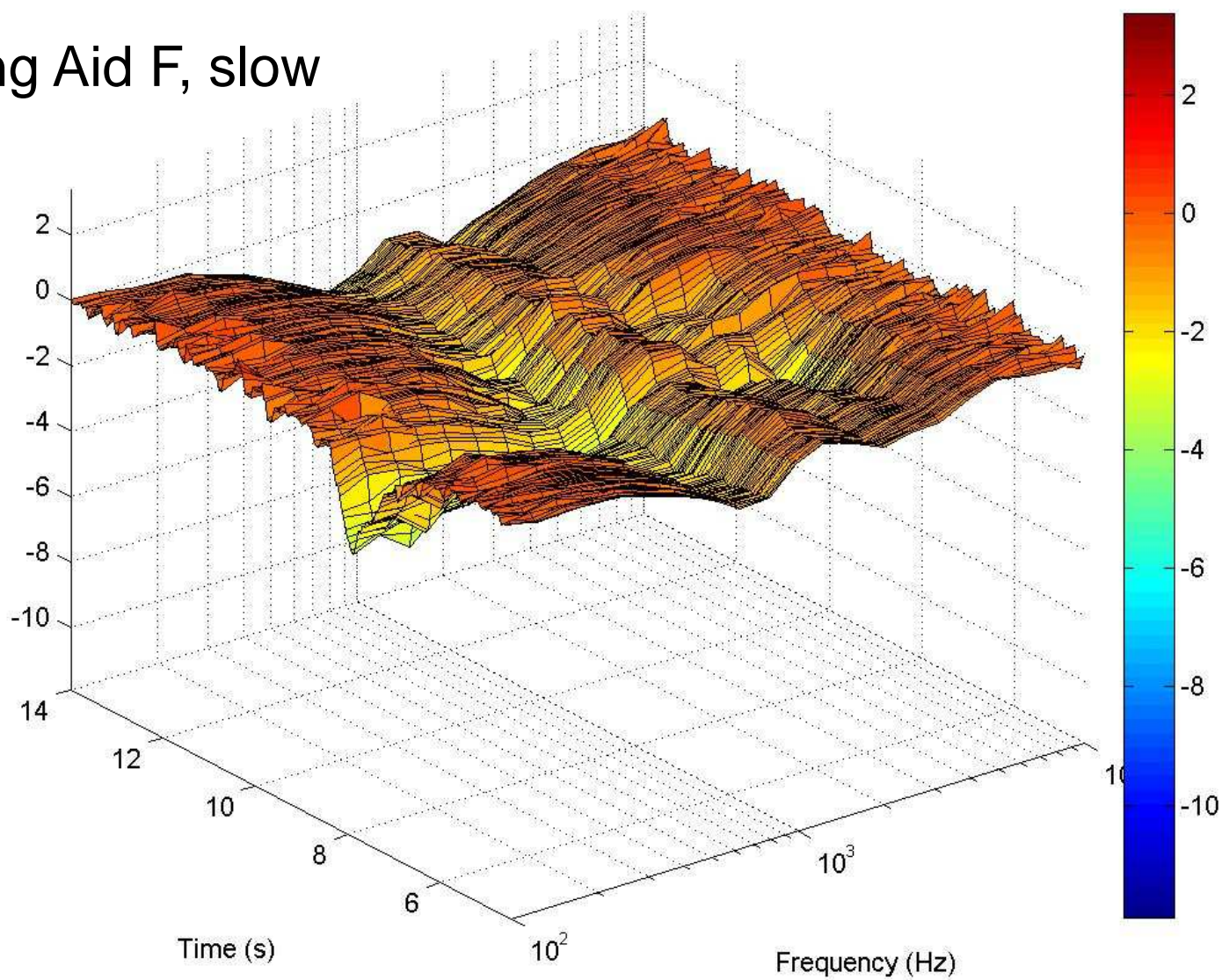
Other ways to illustrate what we have  
seen in the movies?

Hearing Aid I, fast



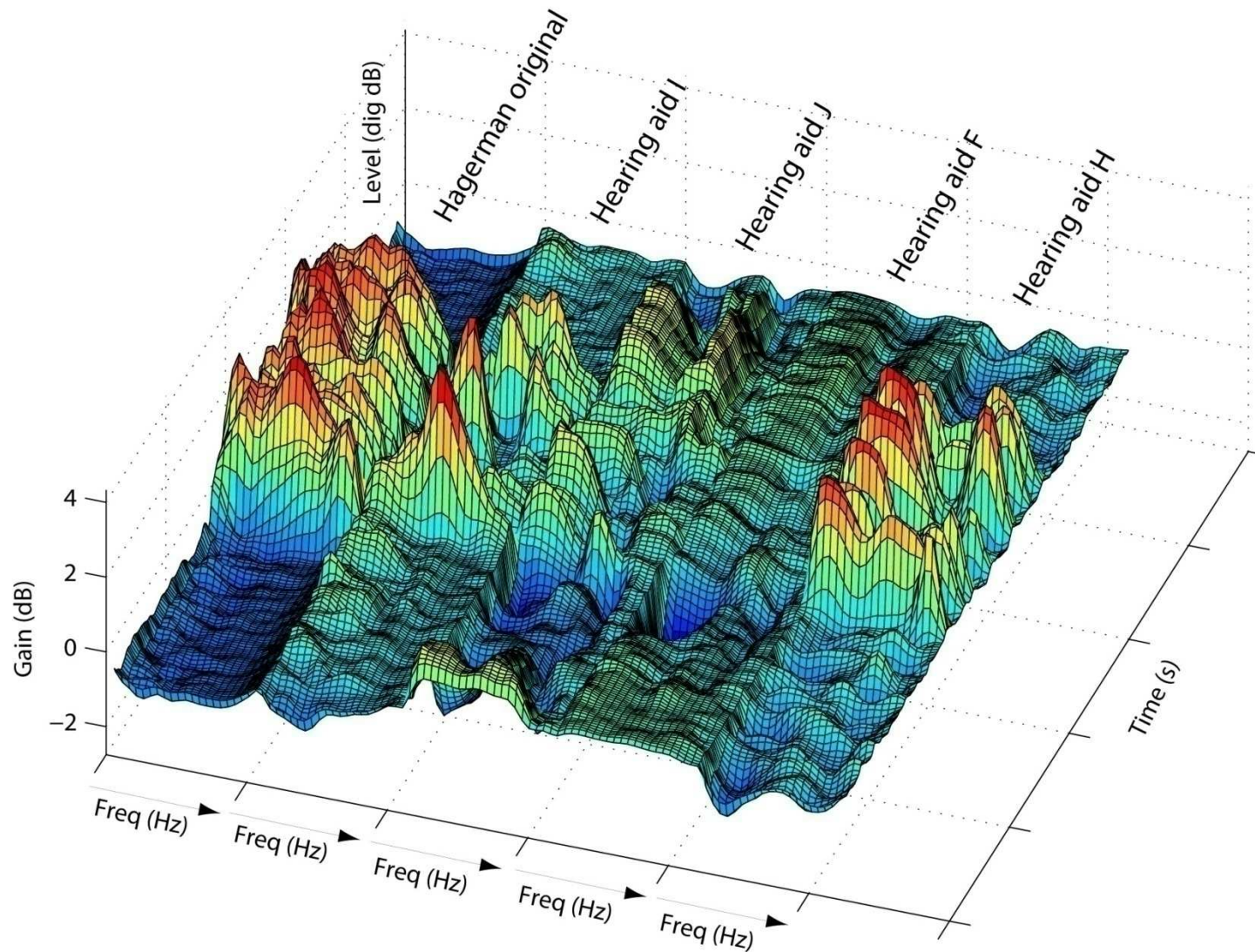


Hearing Aid F, slow

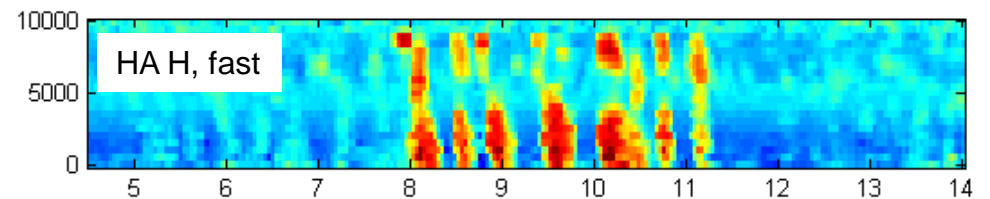
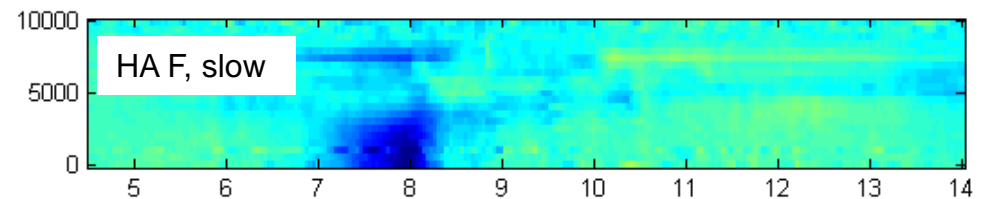
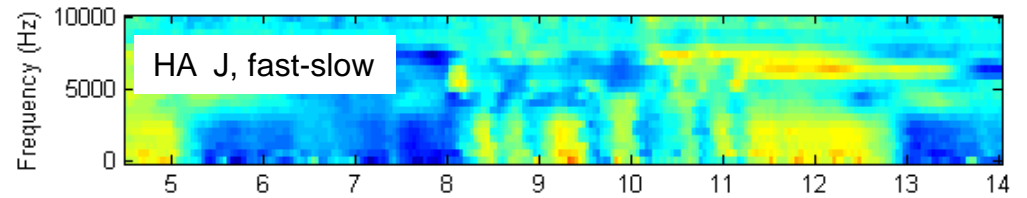
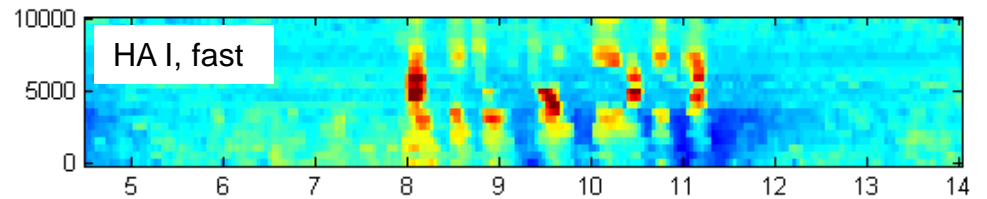
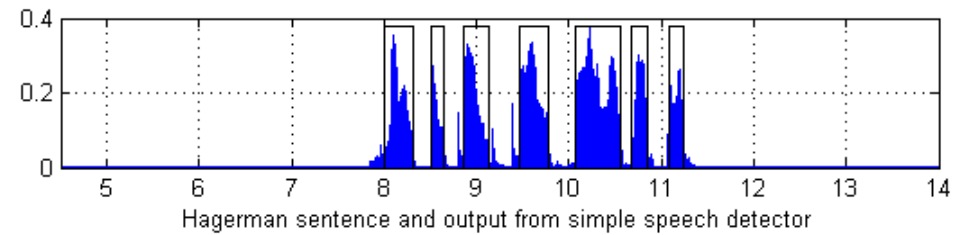




# Change in reduction when long-term average NR is subtracted



Change in reduction  
when long-term  
average NR is  
subtracted.  
"Spectrogram"



## Summary

- Large differences in how the various NR systems work!
- The short-term aspects are needed to describe the noise reduction systems (and they most likely have perceptual relevance)
- Future work
  - Evaluate the systems with hearing-impaired listeners...



Thank you for your attention!

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