Noise reduction (NR) in modern hearing aids

Long-term average measurements using speech

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ABSTRACT

The current study aims at showing how noise reduction algorithms of contemporary hearing aids function for real speech in noise. Coupler gain measurements in an acoustic test chamber were performed using ten modern hearing aids and a real speech signal in stationary speech-weighted noise. Recordings of the input to and output from the hearing aids, with the noise reduction switched on and off, were used to calculate long-term average gain reductions.

The results, presented as contour plots, show that hearing aid manufacturers have chosen to design their noise reduction algorithms based on completely different principles.

BACKGROUND

Modern hearing aids normally incorporate noise reduction algorithms. There are no standard measurements available that can describe how these algorithms work.

Hoetink, Körössy, and Dreschler (2009) reported long-term average NR measurements using speech-like signals.

The main aim of the current study was to investigate ways to illustrate how noise reduction systems work. A second aim was to explore potential differences among modern hearing aids.

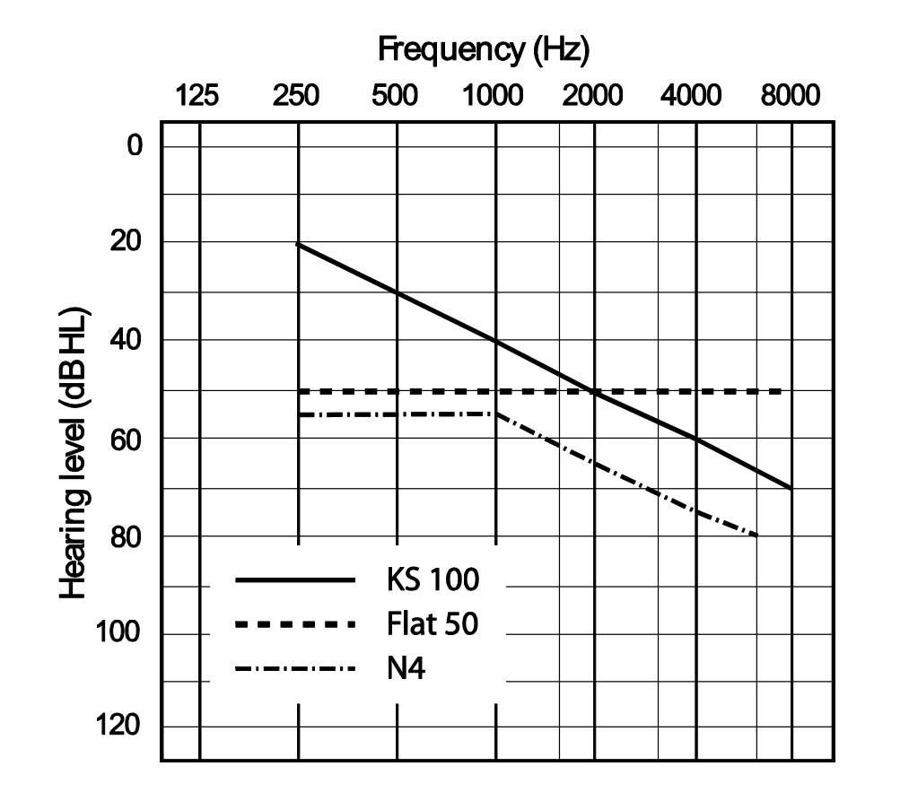
Measurements similar to those made by Hoetink et al. (2009) will be reported. The measurements differ from those of Hoetink et al. mainly in that real speech was used (rather than simulated speech), that the speech levels were kept constant when the SNRs were varied (rather than the overall level), and that comparisons were made between NR on and off (rather than using the gain for clean speech as a reference).

Short-term average gain measurements have also been used to quantify the effect of noise reduction in hearing aids, but these methods are only outlined in this poster.

METHOD

Twelve modern hearing aids were programmed for three hypothetical audiograms. Advanced signal processing was turned off. Coupler gain measurements were performed in an acoustic test chamber and measurements with the NR on and off were compared using contour plots.

Audiograms

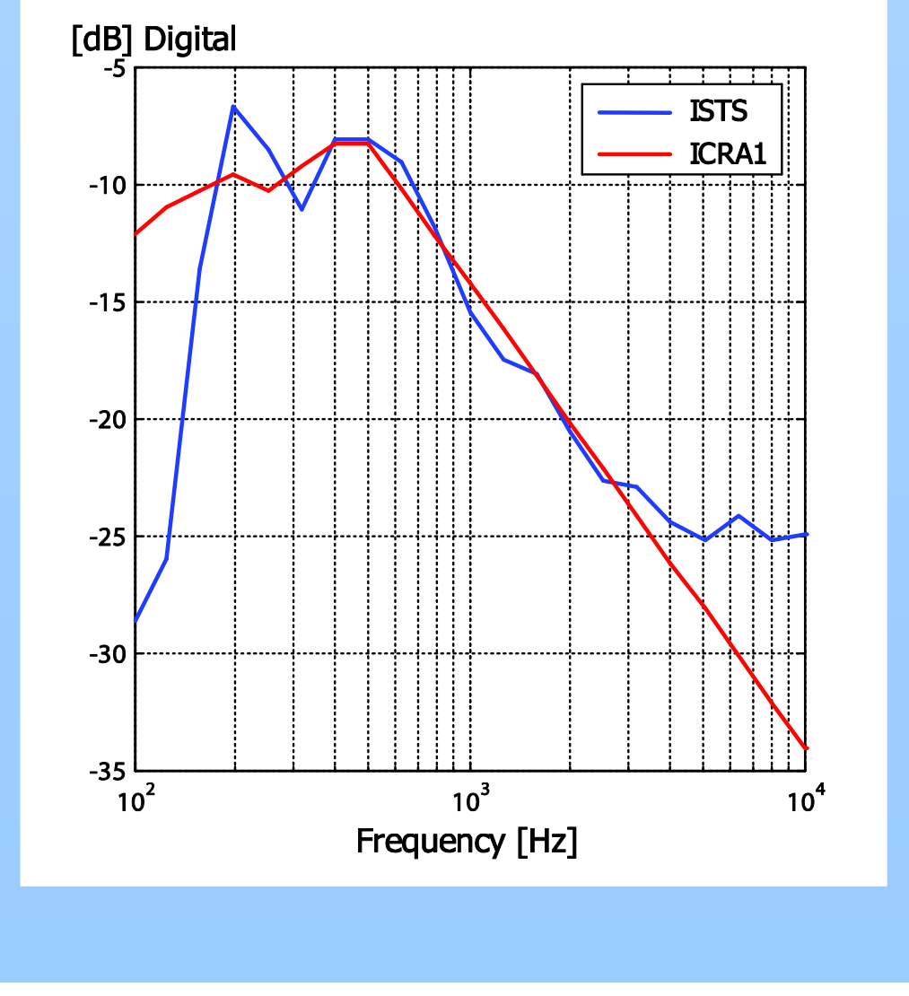


Hearing Aid Programming

- Microphones: OMNI
- MPO: MAXIMAL
- Expansion: OFF
- Volume Control: OFF
- Feedback reduction: OFF
- Other signal processing, OFF

Equipment and Material

- TBS25 test chamber (Interacoustics)
- 711 coupler and microphones (GRAS)
- Speech: ISTS speech signal (EHIMA, 2007) at 62 and 75 dB SPL
- Noise: un-modulated speech-weighted noise (ICRA1, Dreschler et al., 2001)
- SNRs: +6, +3, 0, -3, -6, -9, -12 dB plus one condition with pure speech



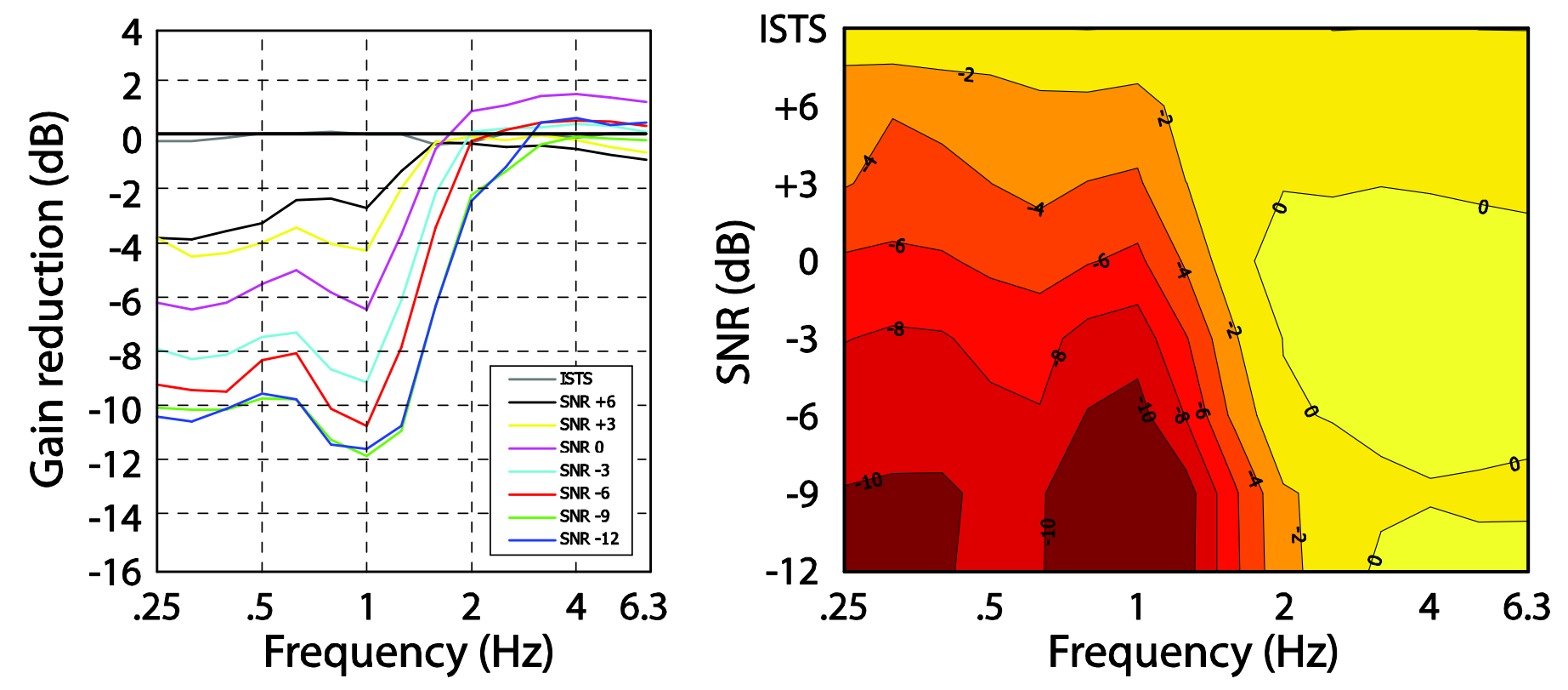
Procedures

- Pre-conditioning: 30 s
- Long-term average: 30 s
- FFT gain curves averaged within 1/3-octave bands from 250 to 6300 Hz.

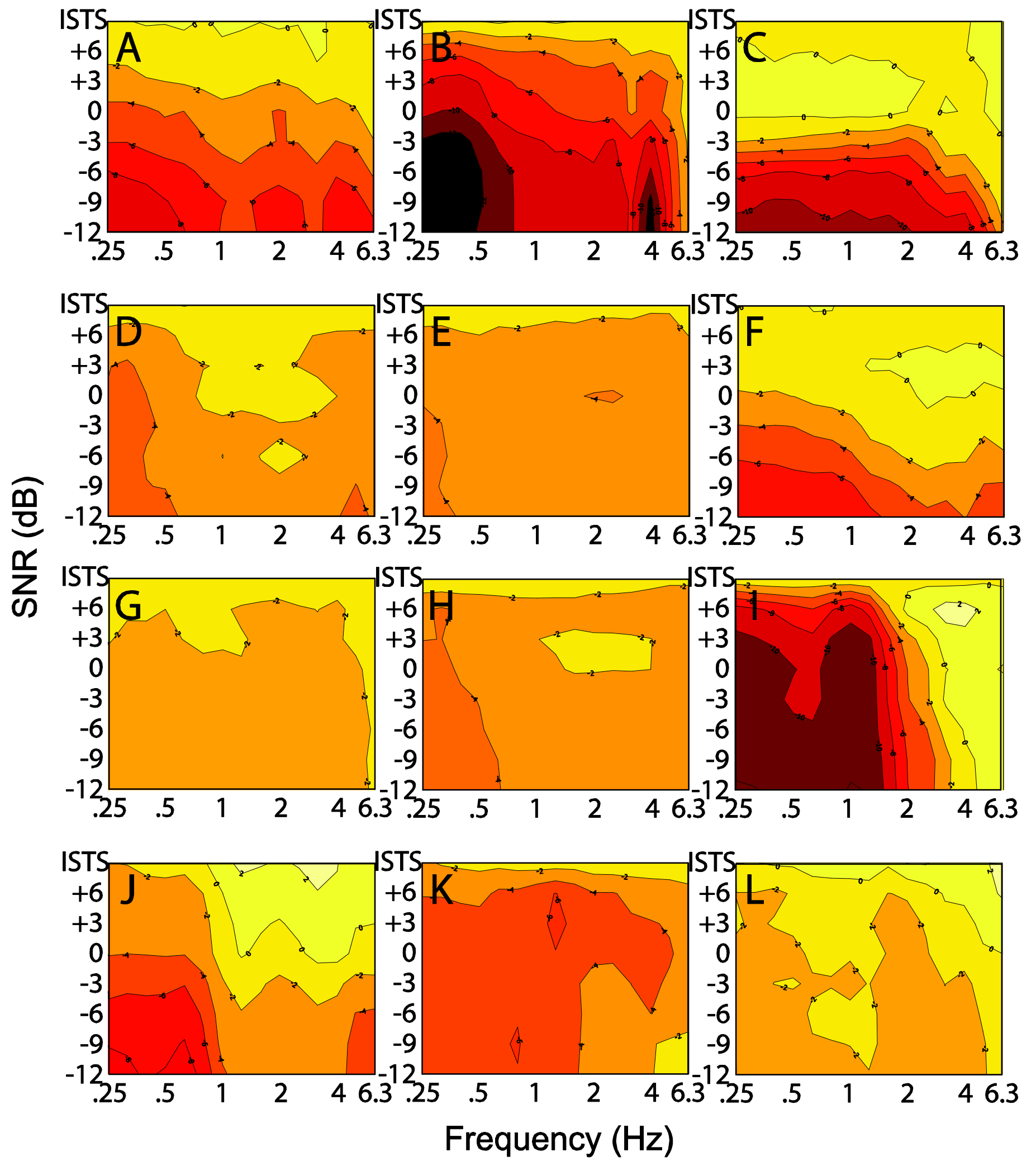
RESULTS

The gain reduction due to the NR was replotted as reduction contours as a function of frequency and SNR.

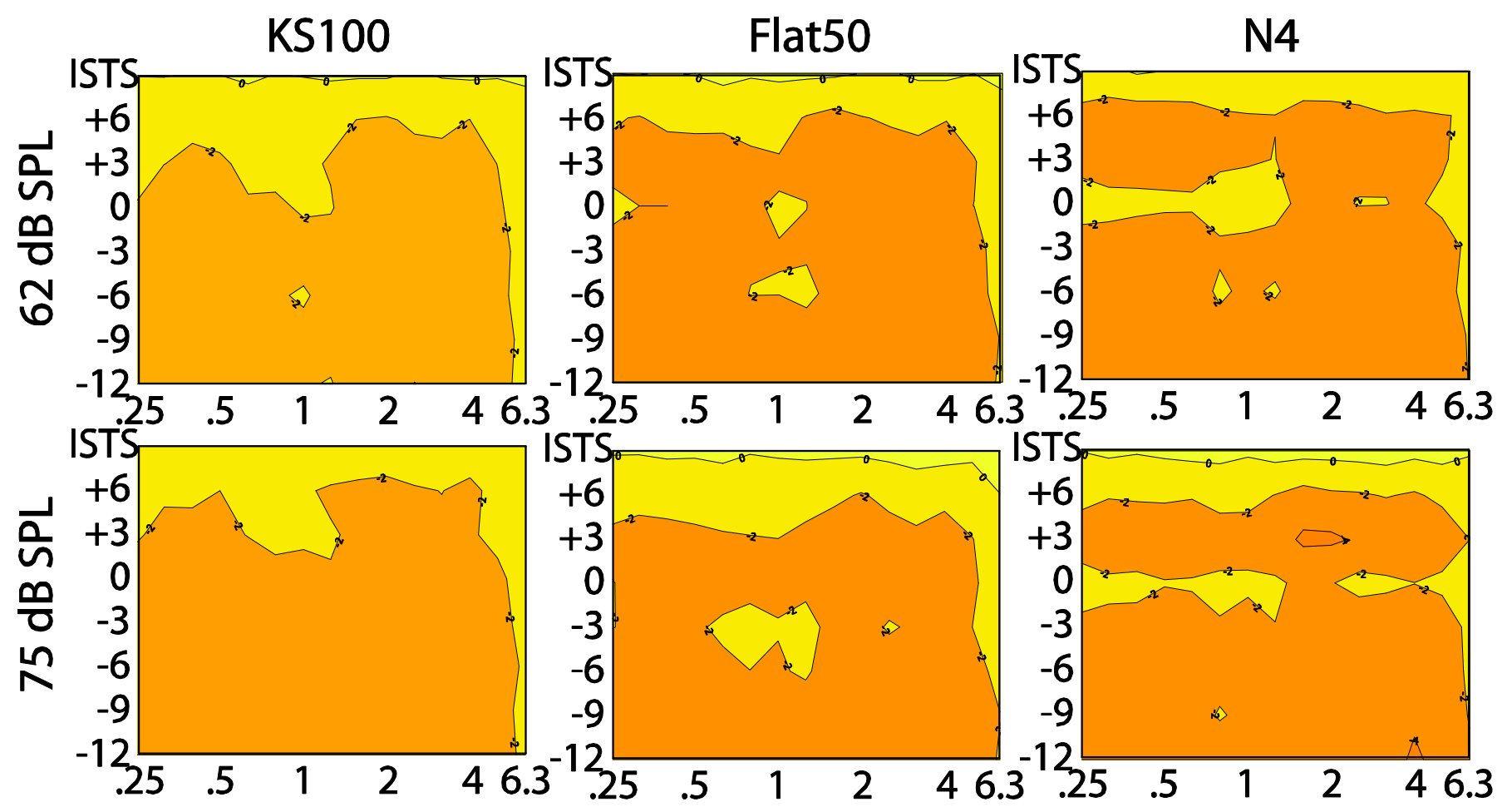
Gain reduction=G_{on}-G_{off} Reduction contours



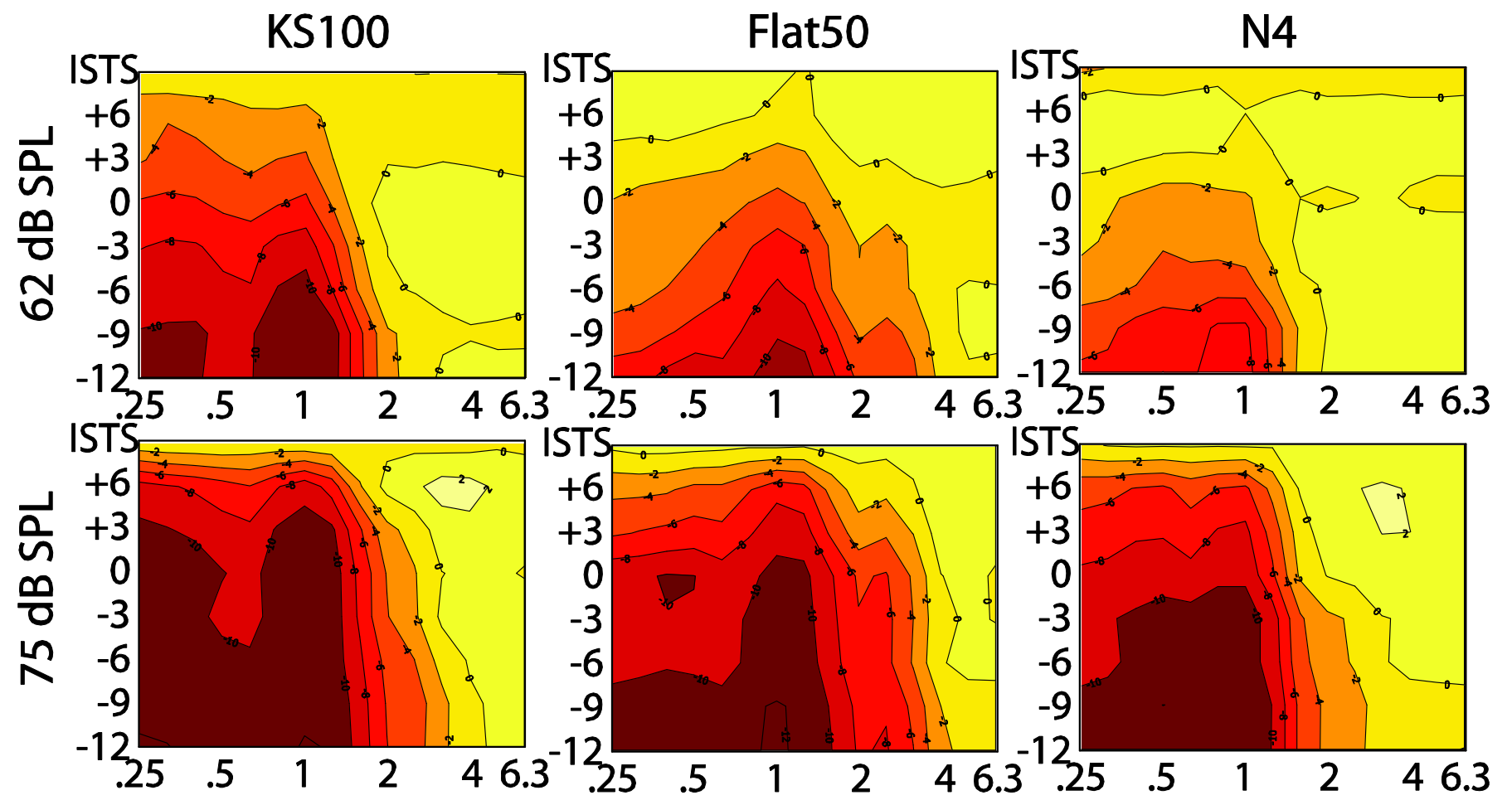
75 dB SPL speech, KS100 audiogram



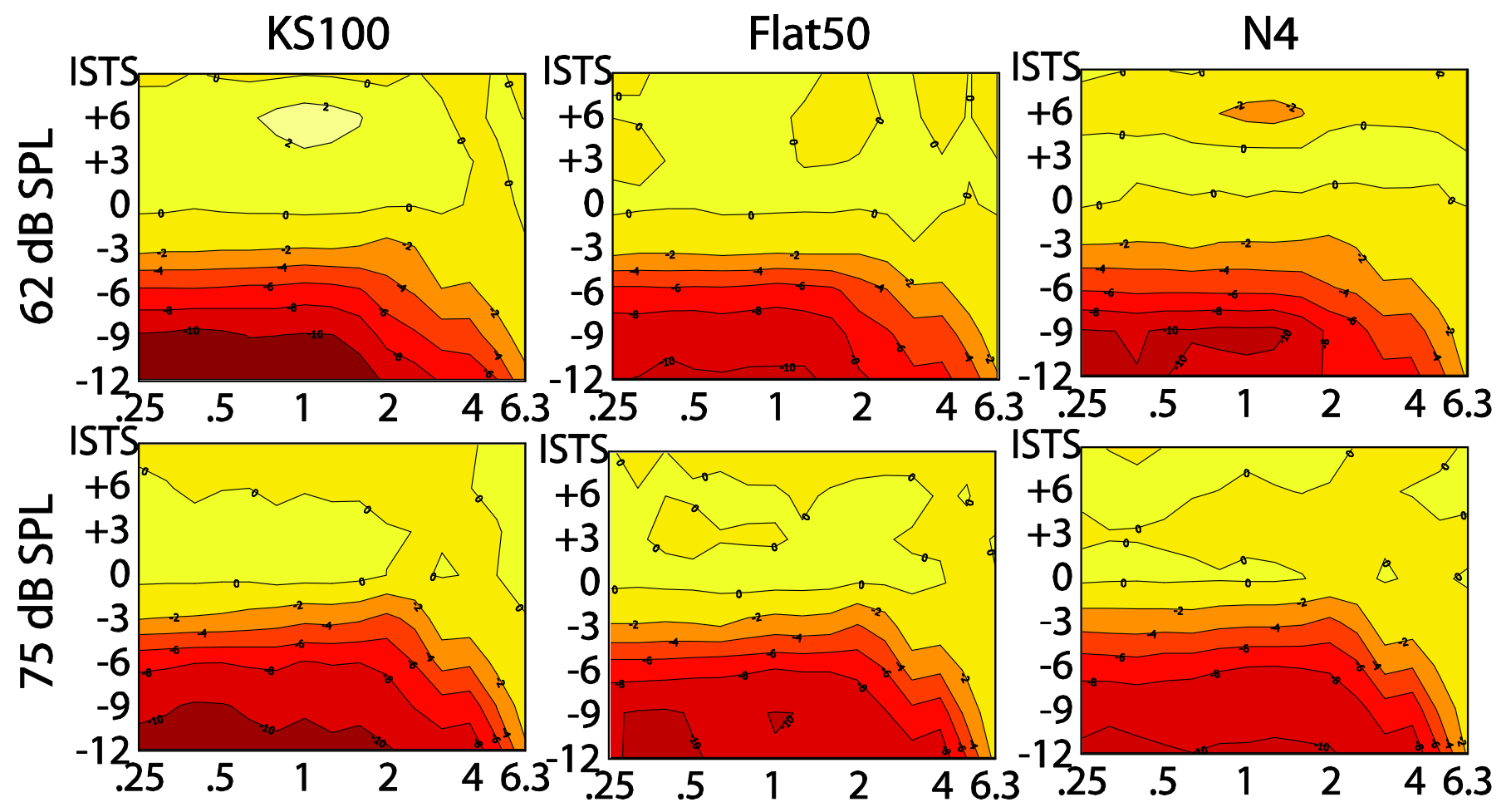
Small gain reduction and small differences between measurement conditions – HA G



Large gain reduction and large differences between measurement conditions – HA I



Large gain reduction, but small differences between measurement conditions – HA C



DISCUSSION

Measurements of long-term average gain reduction have been presented, and have shown that the included NR algorithms are very different. What happens if we study short-term average gain reduction?

We have experimented with various ways to illustrate how NR algorithms function in the short-term perspective. These illustrations include movies where the gain reduction due to the NR is illustrated together with the sound file the hearing aid has processed. This has proved to be an illustrative way to present the data. NR time constants can be studied, and the co-variation between gain reduction in different frequency ranges is easy to see.

We are continuing the work to find ways to illustrate the temporal effects of noise reduction in hearing aids.

CONCLUSION

We have illustrated the effect of noise reduction systems in modern hearing aids. There are large differences between the various systems. These variations include

- the amount of gain reduction
- the frequency range in which the main reduction is applied
- the dependence on SNR
- the dependence on audiogram configuration
- the dependence on speech level

The purpose of reducing noise seems to be different for the different algorithms.

REFERENCES

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