

## Spectral and binaural loudness summation

### in subjects with bilateral hearing loss

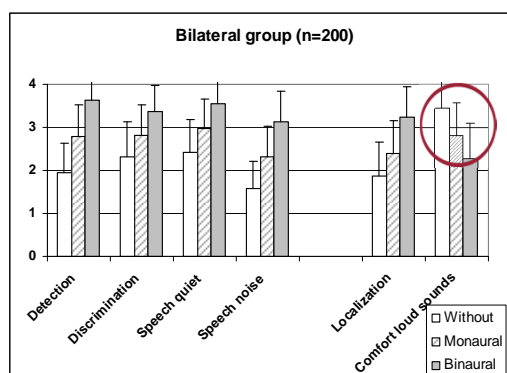
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(<sup>1</sup>AMC Amsterdam, <sup>2</sup>Libra Revalidatie en Audiologie)



## Background --> Goal

- Many hearing aid users have complaints about loud sounds

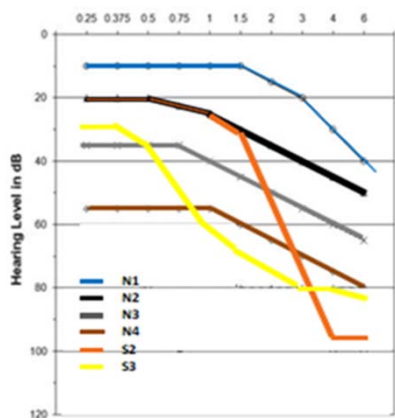


- Understand the complaints about loud sounds in hearing aid users and find a solution.



## Subjects

- Average age: 70 yrs, 12 females, 10 males

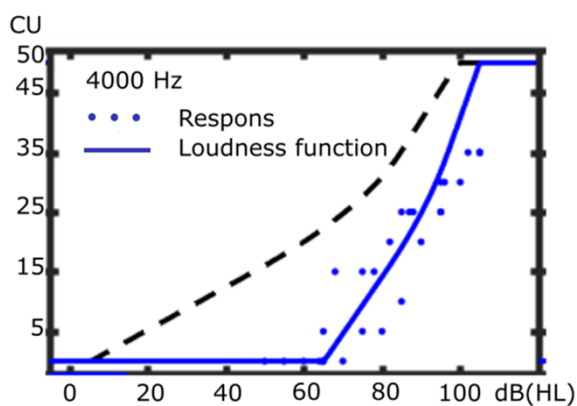
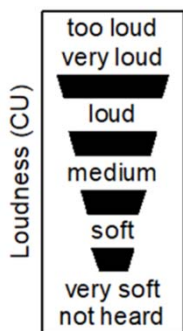


Bisgaard	Nr of ears	Nr of subjects
N1	1	-
N2	11	4
N3	18	8
N4	6	3
S2	6	2
S3	2	1

Bisgaard N et al.; Trends Amplif. 2010 Jun;14(2):113-20

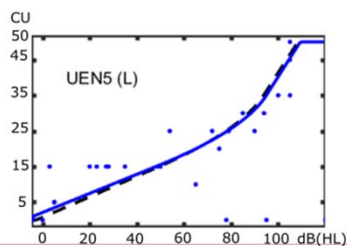
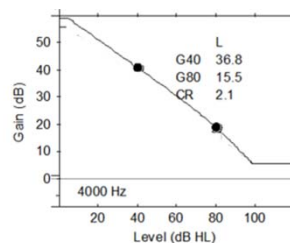
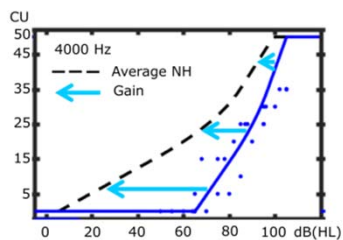


## Loudness scaling



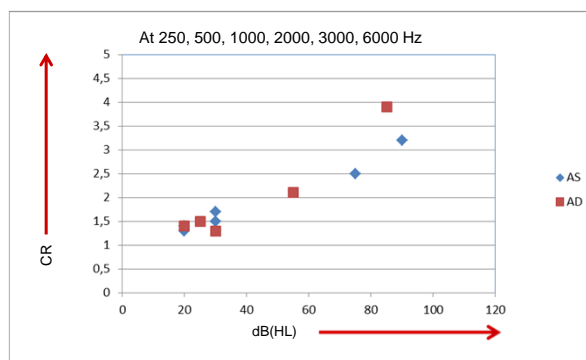
## Loudness scaling for NB signals

tested at 250, 500, 1000, 2000, 4000, 6000 Hz

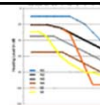


## Individual results (Example)

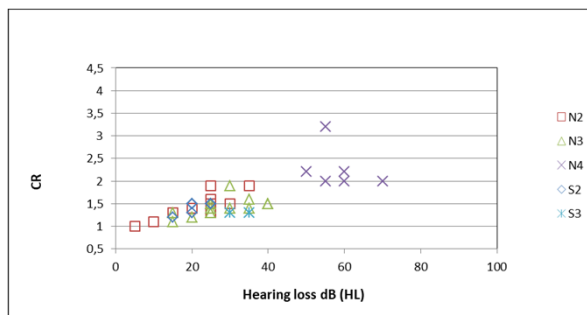
CR results vs dB(HL) per ear per subject for all NB signals



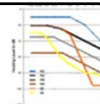
## Group results at 500 Hz



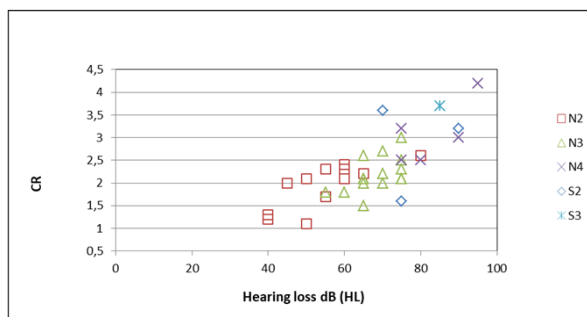
CR results vs dB(HL) per ear for different signals



## Group results at 6000 Hz

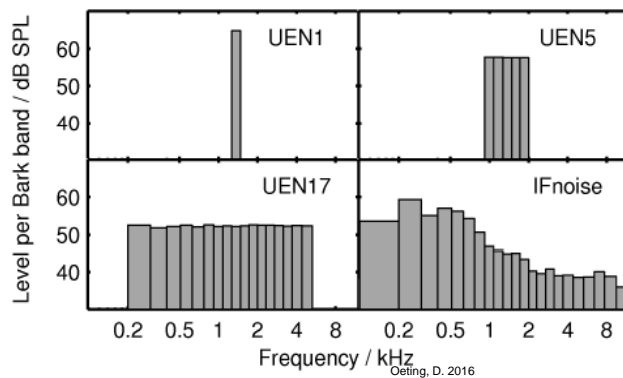


CR results vs dB(HL) per ear for different signals

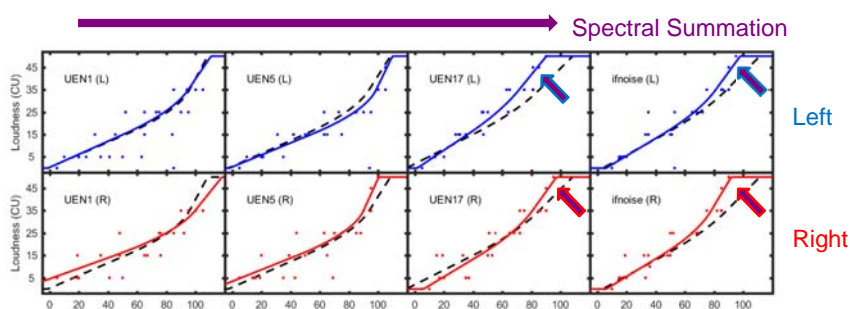
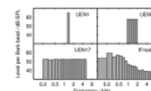


## Broadband signals

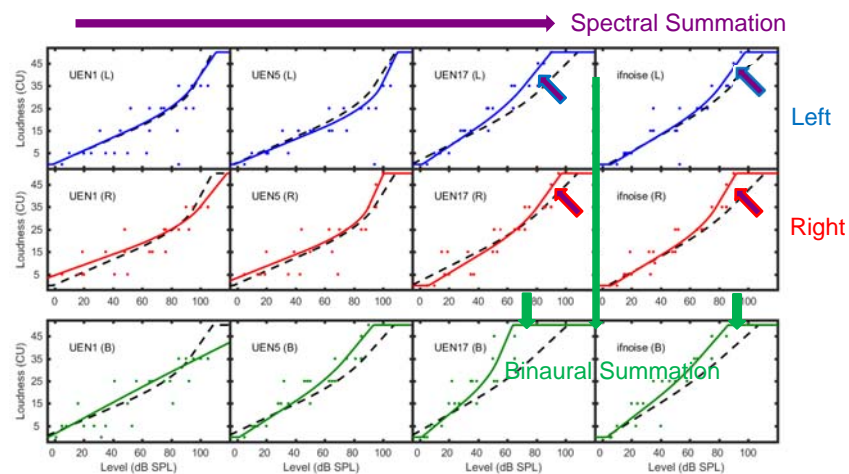
- Spectra and bandwidths of the test signals



## Spectral Summation



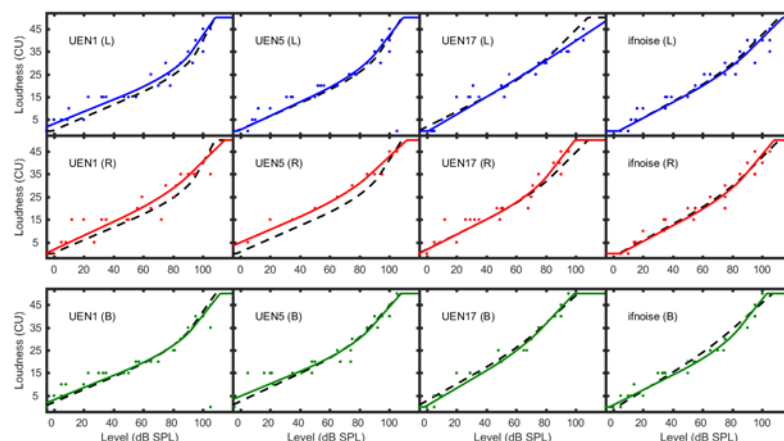
## Binaural Summation



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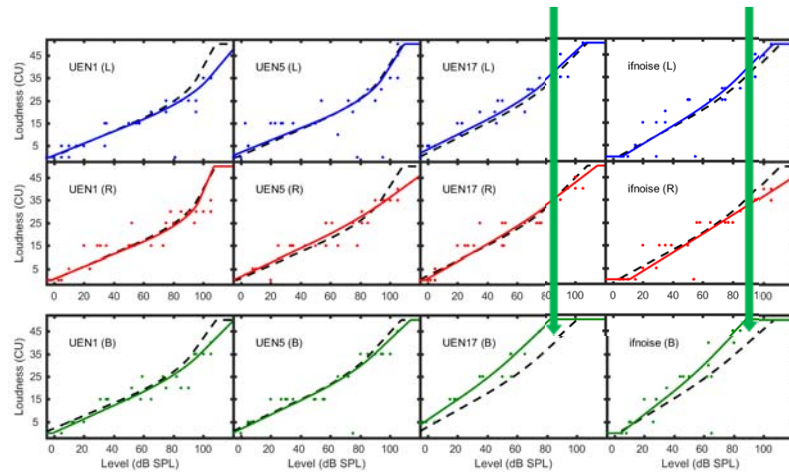
## No summation



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## Binaural summation only



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## Individual results

- Application of this approach for **gain compensation** is able to **restore normal loudness perception** for NB signals
- However, huge **inter-individual variability** is found for **broadband** signals and for **binaurally** presented signals
- This may explain the **subjective complaints** in subjects with bilaterally fitted hearing aids.
- **A fixed gain reduction** in bilateral fittings (e.g. 3 dB) seems to be **inadequate** for some subjects in this study

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## Loudness matching

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- Preliminary experiments show equivalent results in **less** testing time
- Large inter individual differences, but the **same trend** in loudness matching and Loudness scaling, with pink noises

## Conclusions

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- A clear **spectral - and binaural** loudness **summation** is found in this study
- However there are **large inter individual differences**
- There is a need to **adjust fitting rules** for bilaterally fitted hearing aids, based on a fast clinical test instrument (Loudness **Matching**)