

Auditory model for the speech audiogram

from audibility to intelligibility for words
(work in progress)

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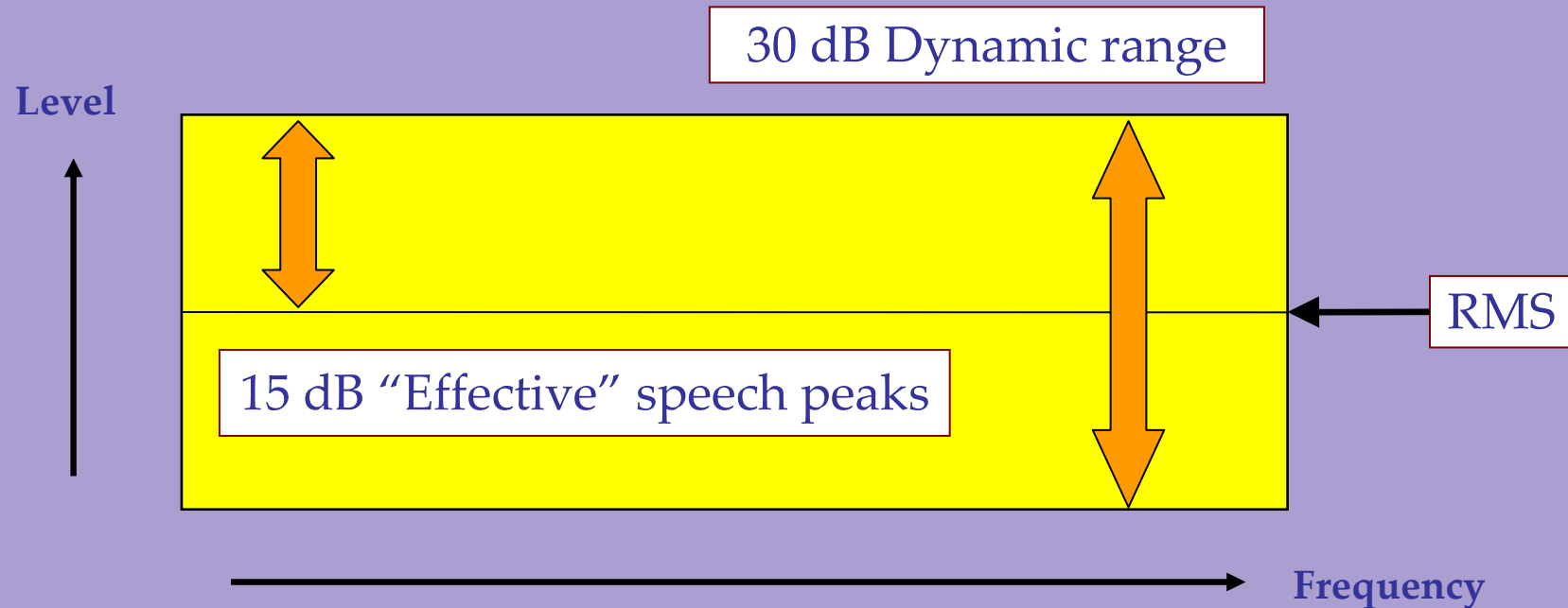
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Introduction

- **History:**
 - **Standard model for sentence intelligibility: SII**
 - **Modified model for sentence intelligibility: SIIcmp**
 - **Comparison of SII and SIIcmp for SRTn and SRTq**
 - **Relation Audibility vs. Intelligibility for sentences**
- **? Relationship Audibility and Intelligibility for words ?**
- **Database of speech audiograms: word scores**
- **Audibility from modified model for words in quiet**
- **Relationship Audibility and Intelligibility for words**
- **Discussion**

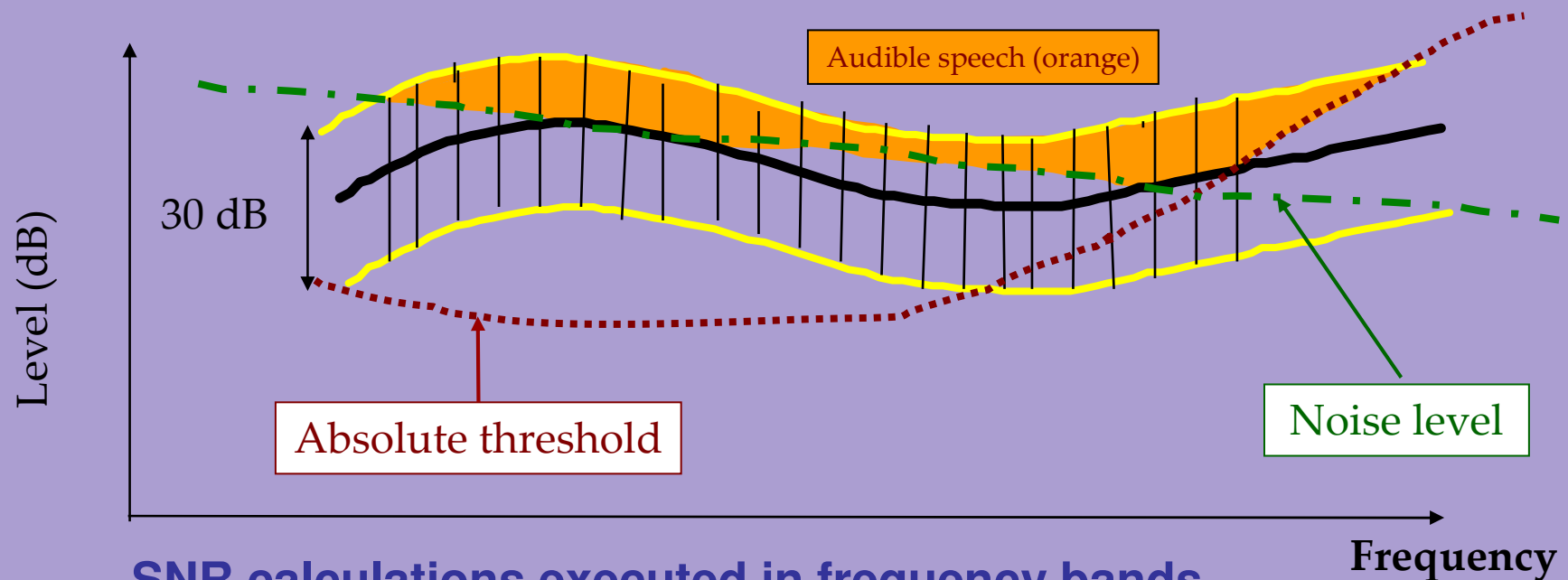
Speech Intelligibility Index: SII



Assumptions:

- Speech dynamic range of 30 dB, RMS in the middle
- Intensity Importance Function: linear from -15 to +15 dB

Calculation of the SII



- SNR calculations executed in frequency bands
- Only the proportion of speech (orange) above the noise and absolute threshold contributes to the SII
- So: it is basically an Audibility measure!

Novel SI model with compression

Introducing compression in the SI model:

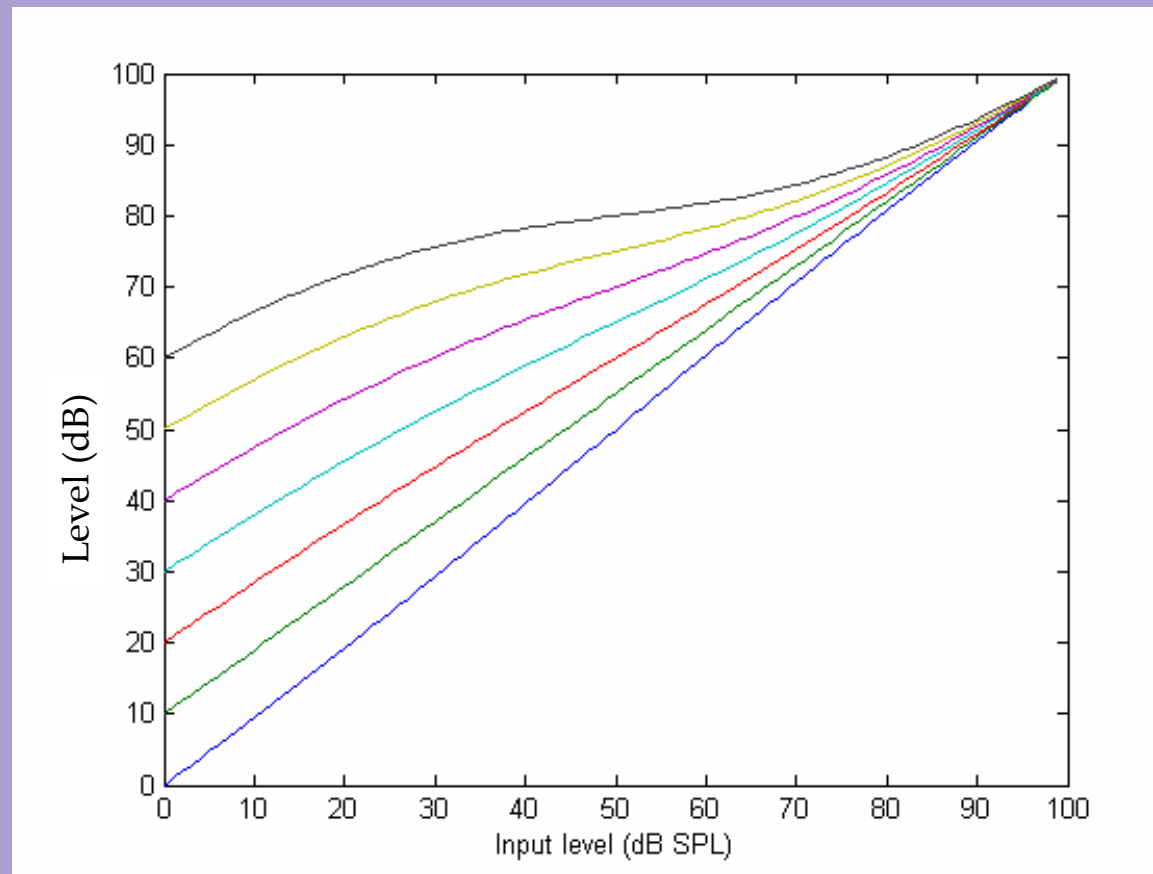
- (1) At normal speech levels (ca 65 dB SPL), hearing in NH listeners is highly compressive
- (2) At very low levels, and for HI listeners, it is not

The SII was designed for NH at normal speech levels (1)

**We introduced compression in the calculations (1),
as function of presentation level and hearing loss (2)**

And we tried various speech-dynamic ranges

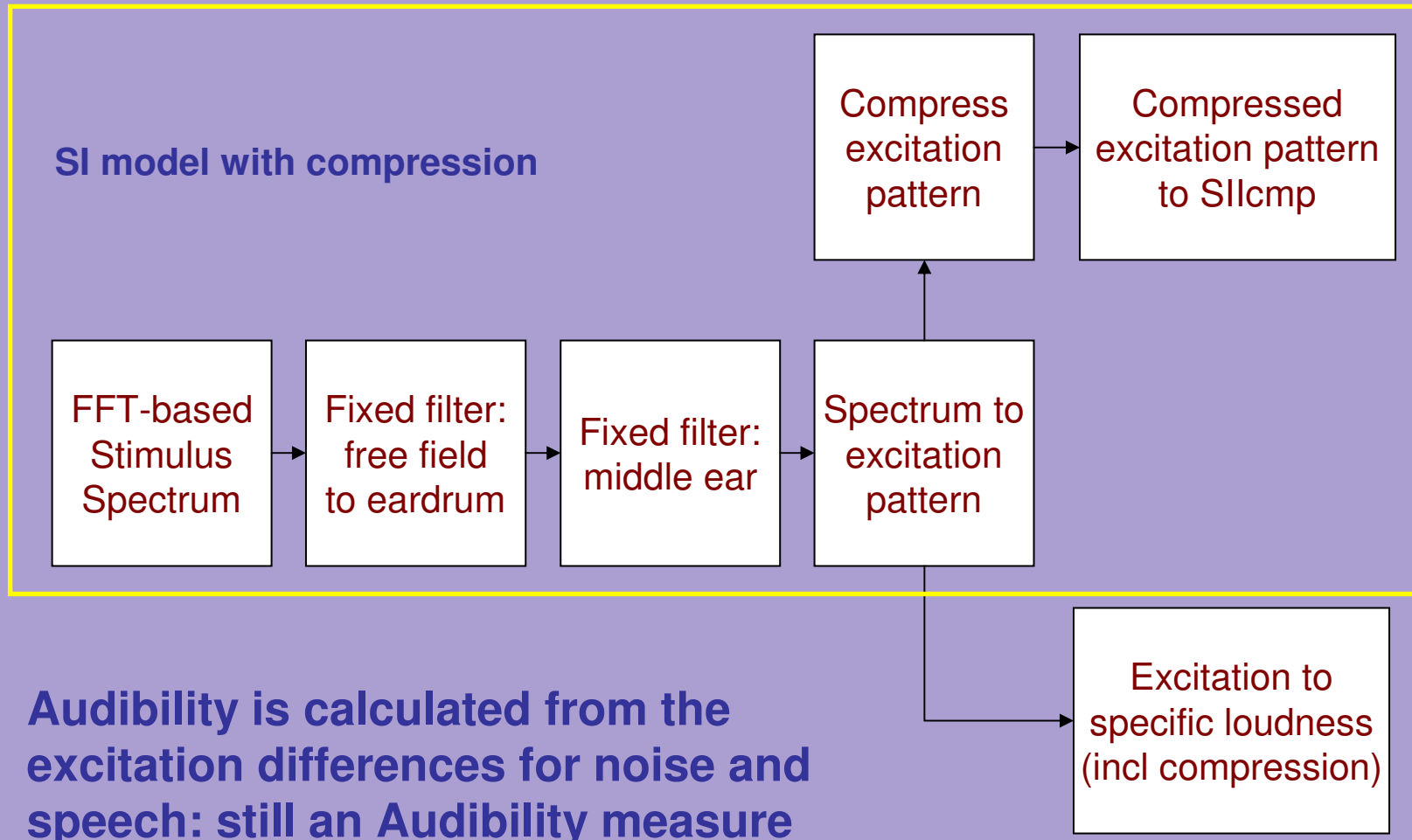
The compression function



After Oxenham, 1995 (PhD thesis)

Schematic diagram of the model

(Rhebergen, Lyzenga, Dreschler & Festen, in press)

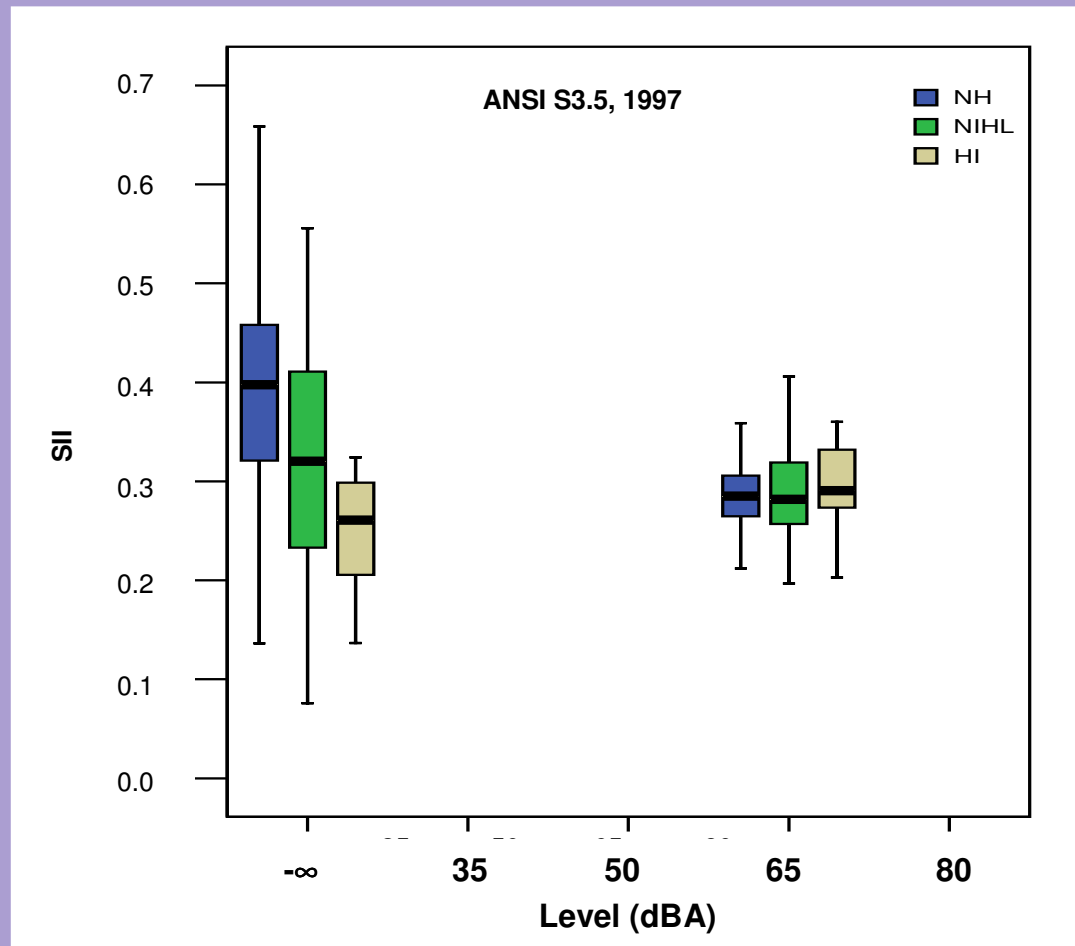


Standard SII predictions

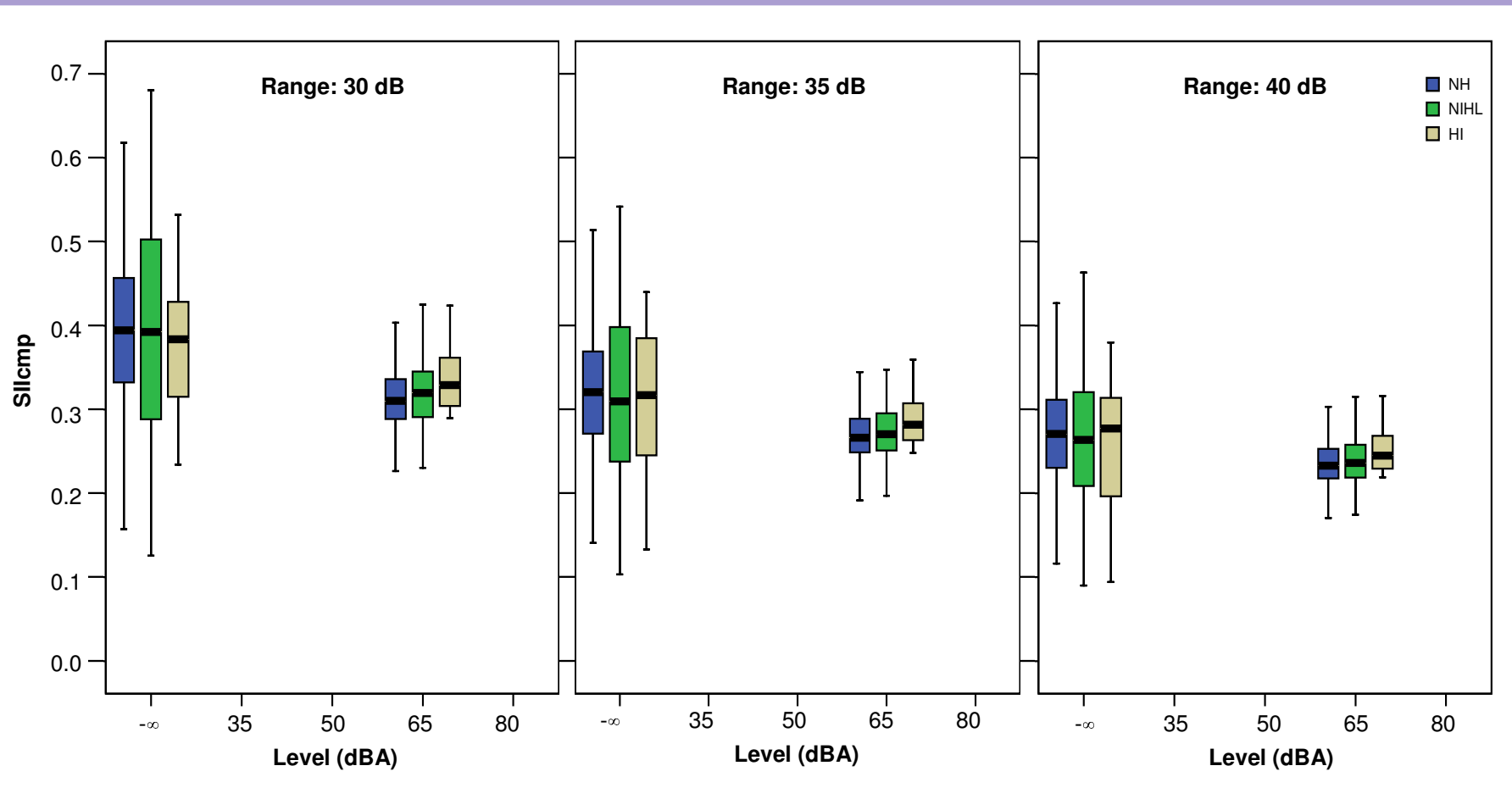
Data set of
factory workers:

- Maintenance work shop for aircrafts.
- 323 NH: blue
- 65 NIHL: green
- 14 HI: gray

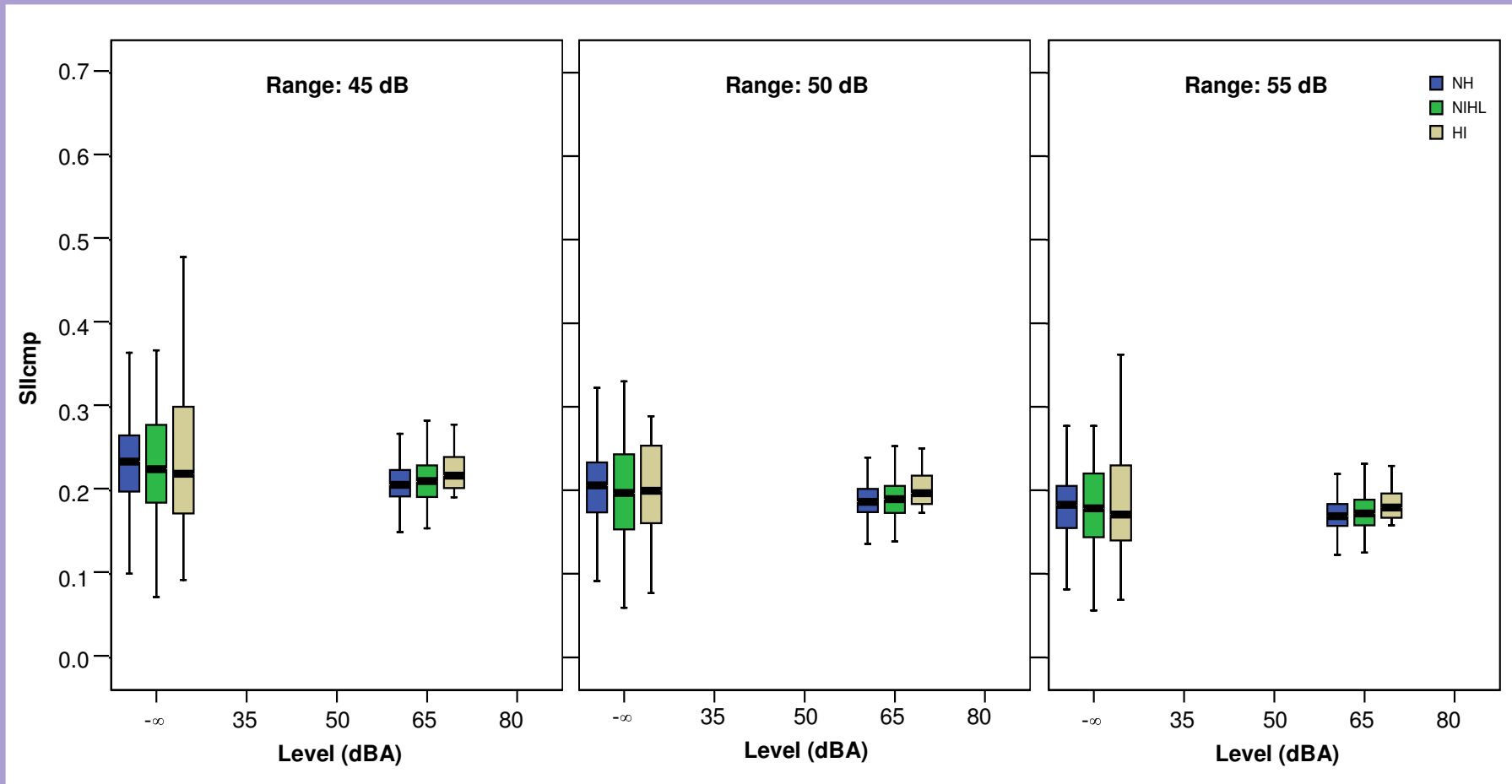
- SII's in quiet decrease with hearing loss !



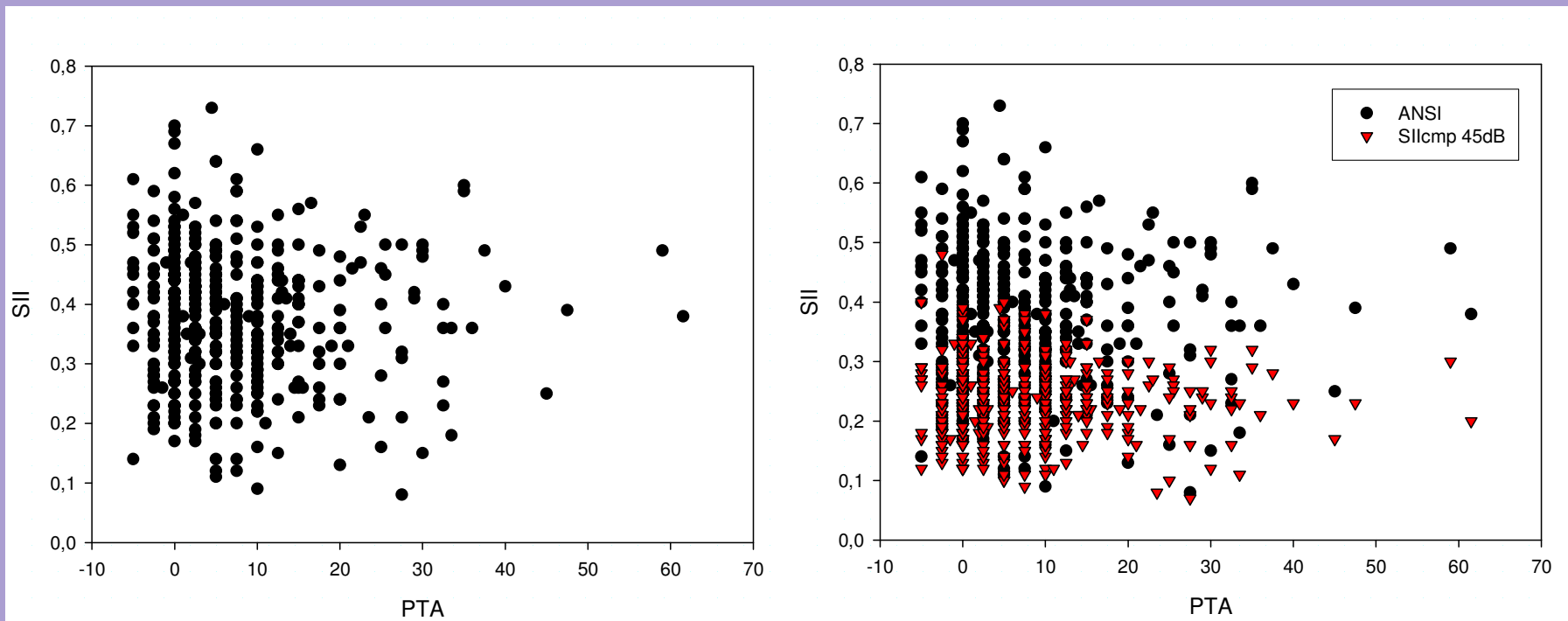
SI predictions with compression (1)



SI predictions with compression (2)

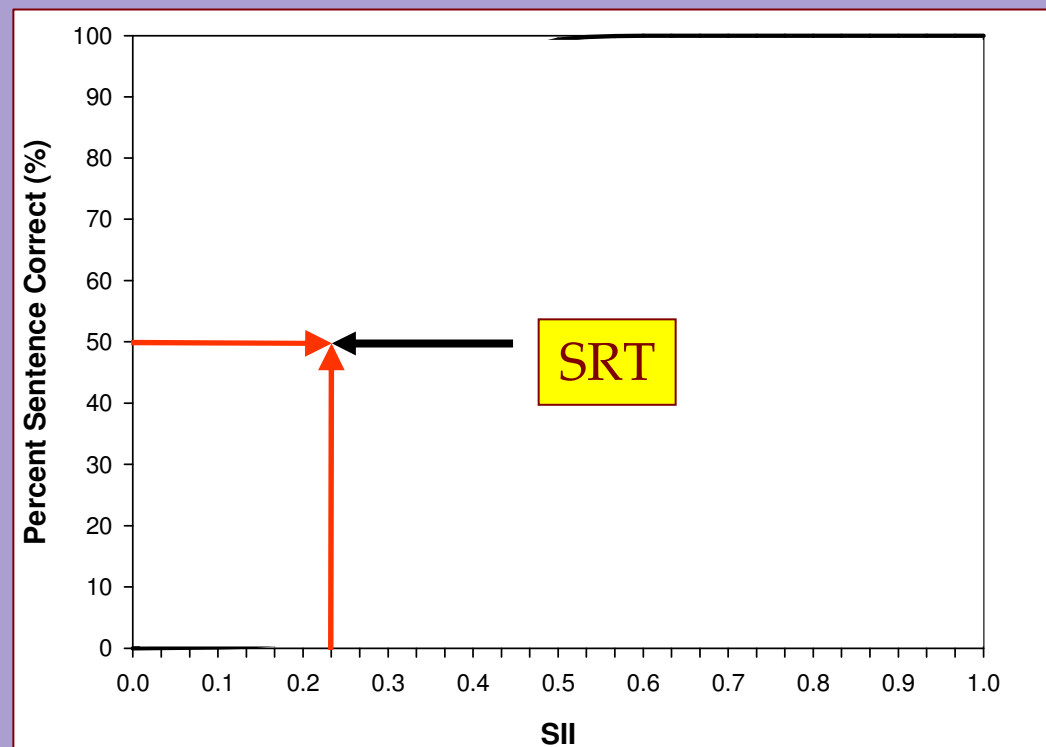


SRTq spread of the SII and SIIcmp values



Relationship Audibility and Intelligibility

SRTs: short, meaningful, sentences in stat. noise



45-dB speech dynamic range optimal for SIIcmp

50% sentences correct gives an SII of appr. 0.22



Relationship Audibility and Intelligibility

First for words?

Why words...

- Few data sets of psychometric functions for sentences
- From sentence audibility to intelligibility: very complex
 - Physical cues, syntax, semantics, prosody, grammar, etc
- From word audibility to intelligibility: less complex
- A lot of data available for words as function of level
 - Database: years of clinical measurements at the AMC
 - Both speech and pure-tone audiograms available
 - Diverse population: NH, M-HI, S-HI, and intermediates

Available data set

Speech audiogram: word scores for at least 3 levels

Pure-tone audiogram: normal audiometric frequencies

Data from 4 years of clinical measurements

NH: 1479

- Age range [18 – 80(!)]

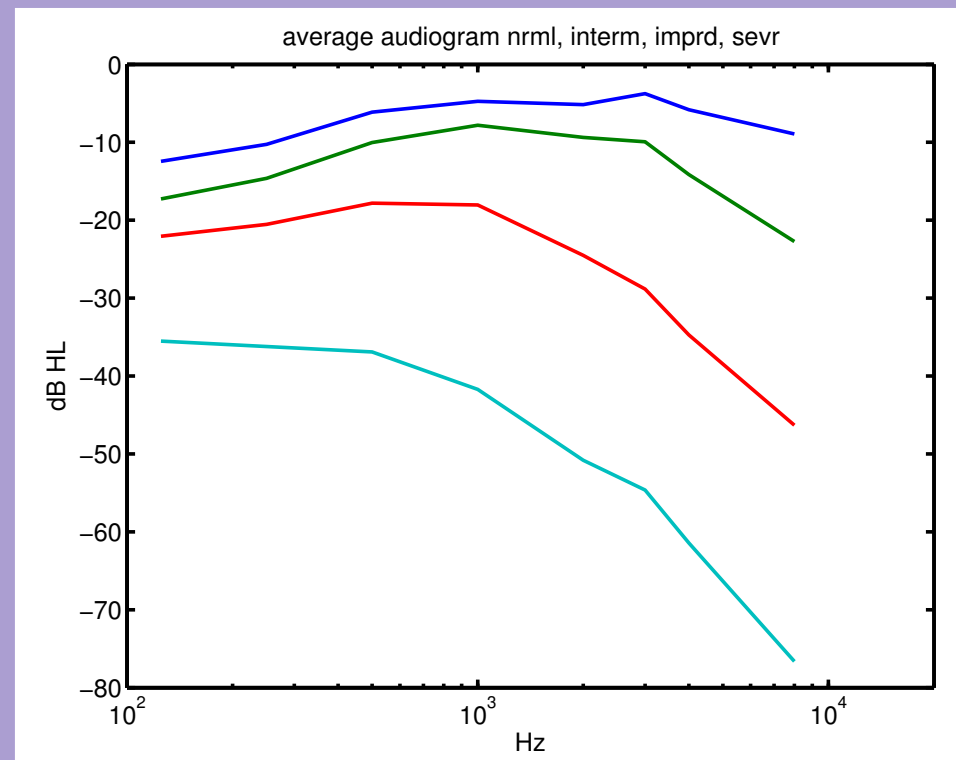
- Avg: 51, SD: 15 years

Not used today:

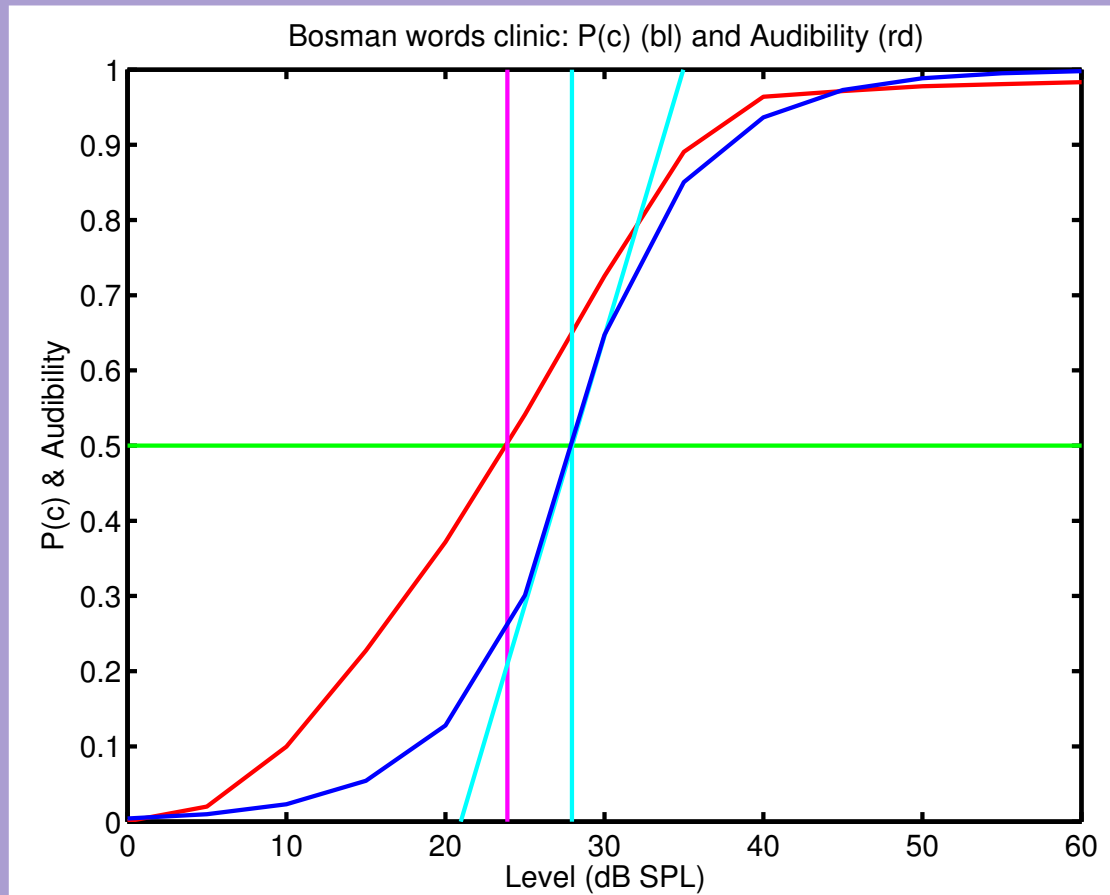
M-HI: 1967

S-HI: 1314

Inter: 1282

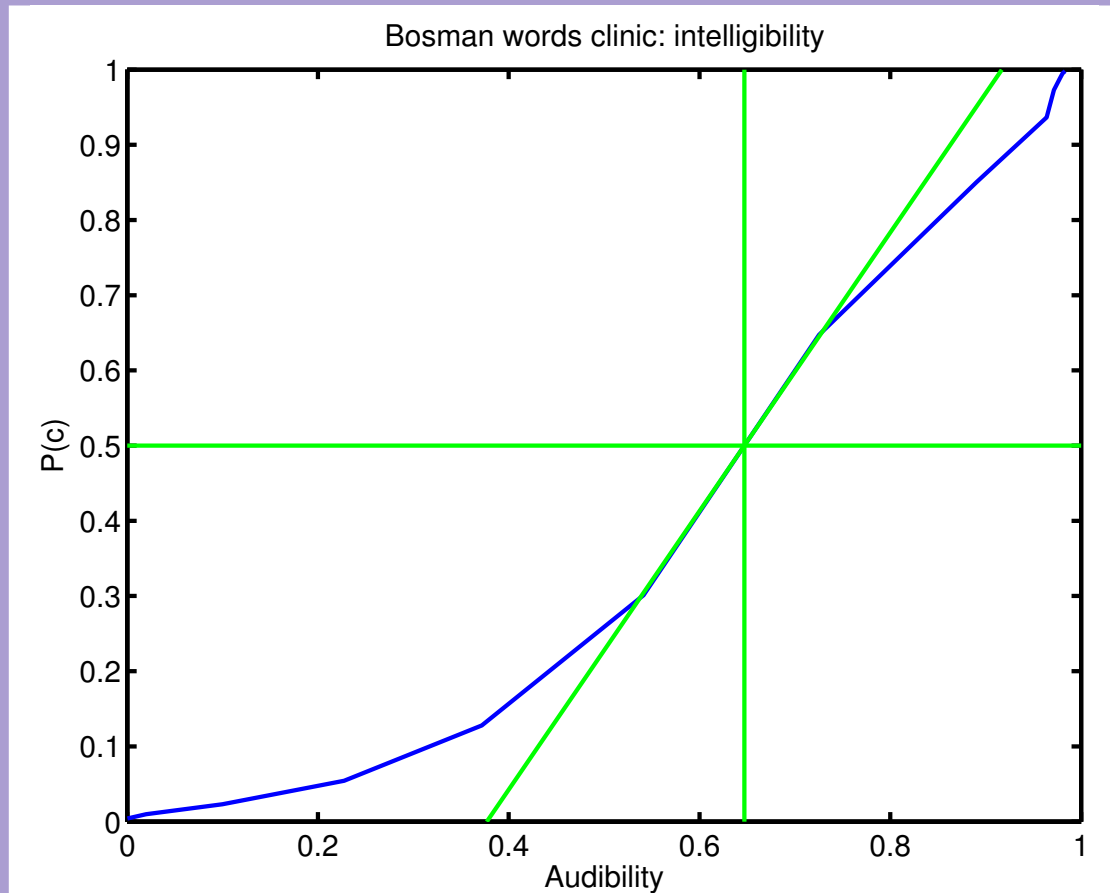


Results for 30-dB speech dynamic range



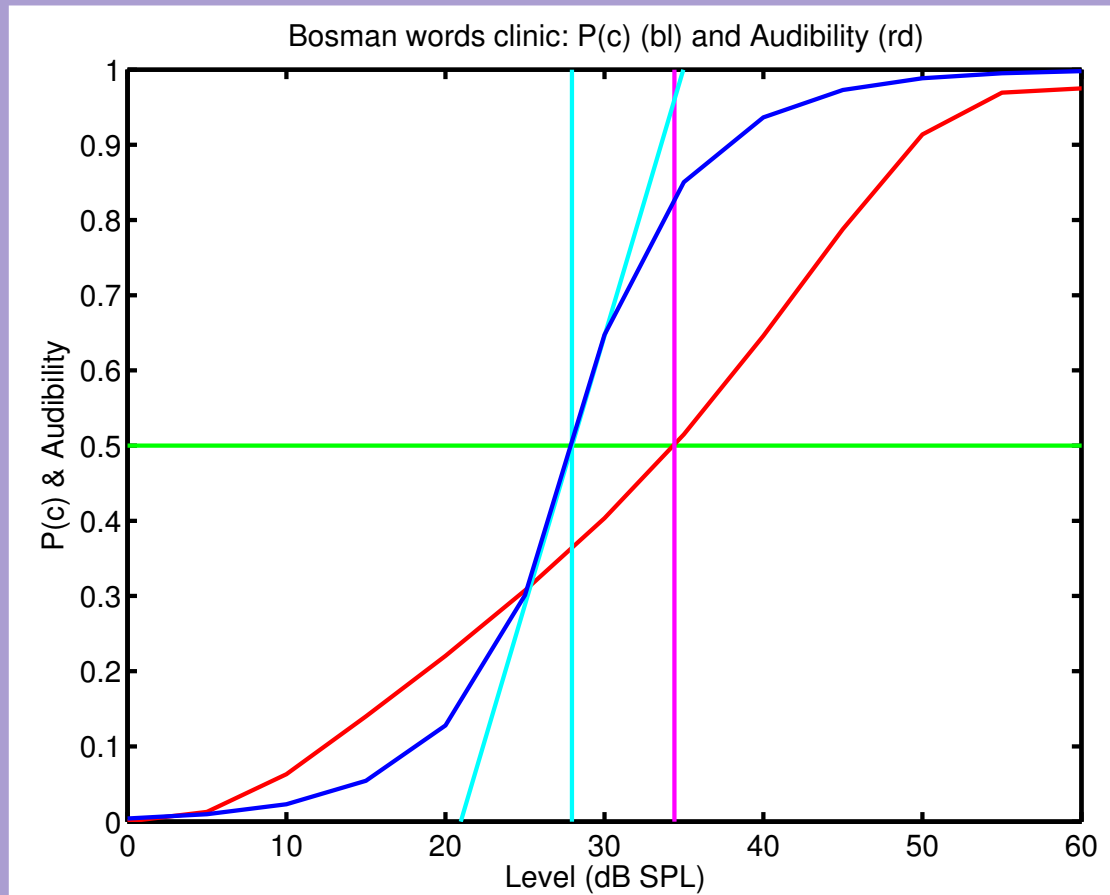
Intelligibility and Audibility for Presentation Level

Intelligibility vs. Audibility: 30-dB dyn.



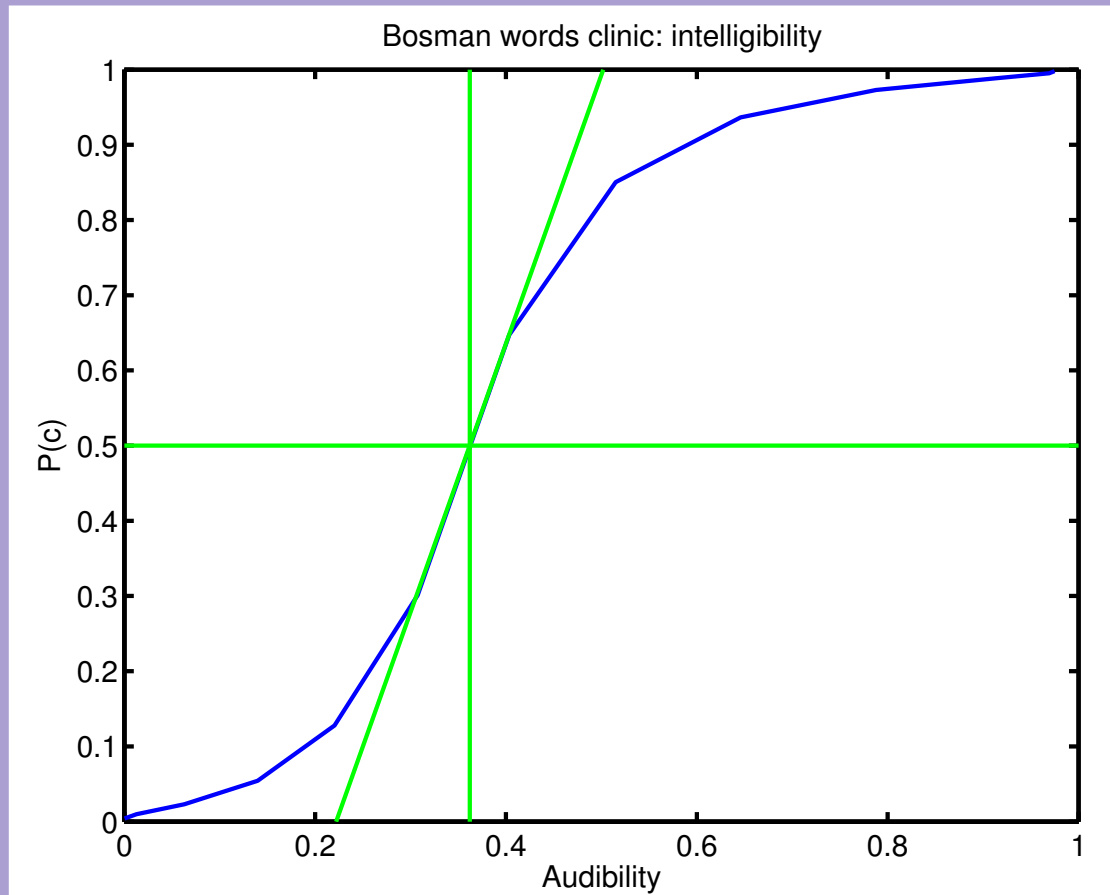
50% Intelligibility for Audibility of approximately 0.65

Results for 45-dB speech dynamic range



Intelligibility and Audibility for Presentation Level

Intelligibility vs. Audibility: 45-dB dyn.



50% Intelligibility for Audibility of approximately 0.35

Bosman: Intelligibility vs. Audibility in NH

Dyn Range	Intelligibility	Audibility
30 dB	50%	~0.65
45 dB	50%	~0.35
Sentences	50%	~0.23

Thesis Bosman for NH listeners:		
Stimuli	Intelligibility	Level
Sentences	50%	~20.5
Words	50%	~27.5

**Bosman: Word Level for 50% correct is a bit higher →
Word Audibility needs to be a bit higher: 45 dB Dyn. R.**

Discussion

Relationship Audibility and Intelligibility for words:

- Model: plausible relationships for 45-dB speech dyn. range
- The data set shows somewhat different relations than the data from the thesis of A. Bosman (not shown):
 - Refinements needed:
 - Separate age groups for NH
 - Speech dynamic ranges
- Look at relationship: Sentence Audibility and Intelligibility

Future:

- Maybe we can unearth Intensity Importance functions
- Aim: predict word scores from the audiogram: clinic



Fin
End
Ende
Einde