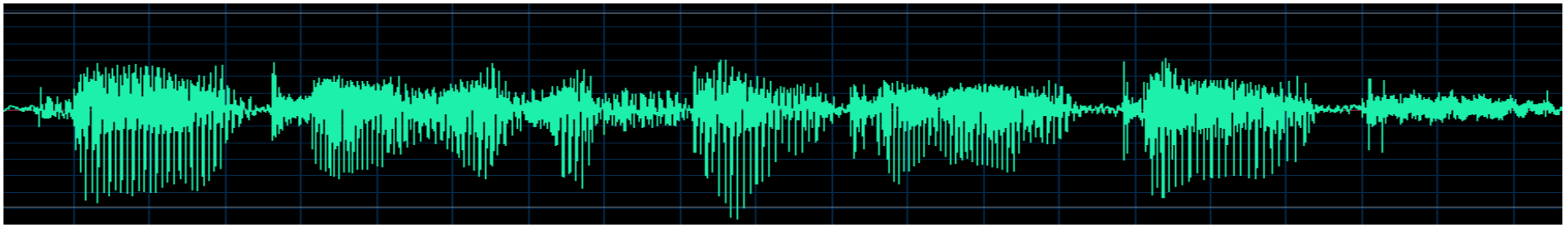
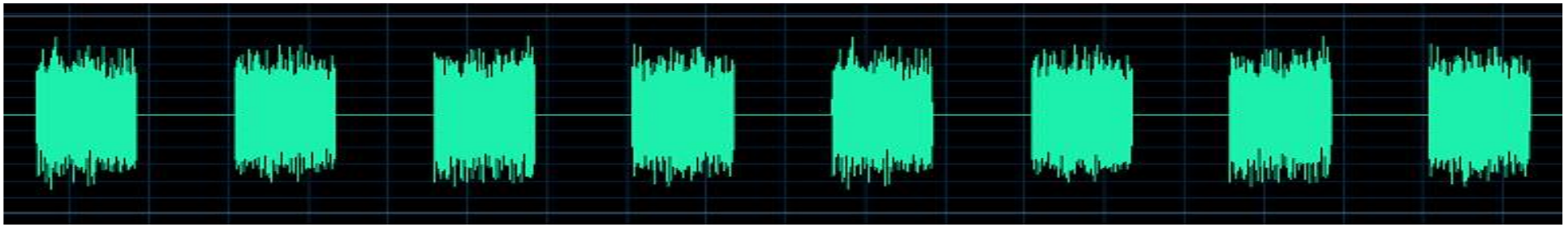


Spraak verstaan in fluctuerend achtergrond geluid bij normaal en slechthorenden als functie van ruis niveau

Koenraad S. Rhebergen
Ruben Pool
Wouter A. Dreschler

NVA Wintervergadering
Vrijdag 30 januari 2009

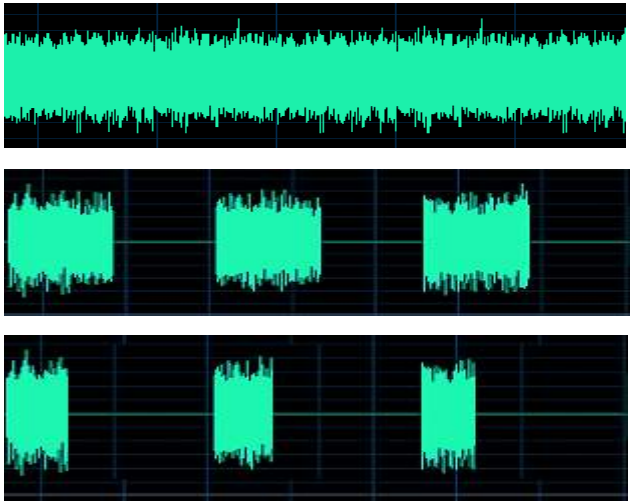


Overview

- Experiment I: the SRT as a function of noise level & noise type
- Experiment II: measuring the temporal resolution
- SRT vs temporal resolution
- Conclusions

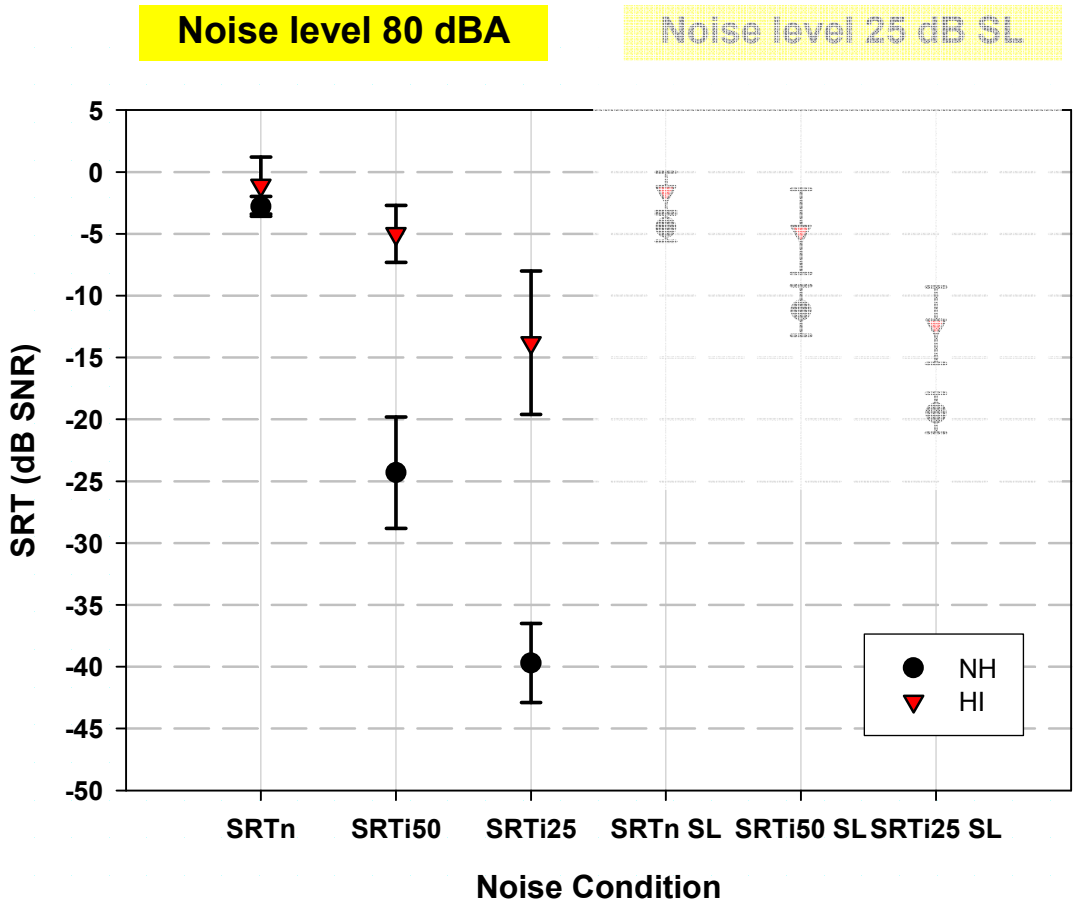
Experiment I

Background noise	Noise level
Silence	-
Stationary	SRTq + 25 dB
	80 dBA
8 Hz interrupted Duty cycle 50%	SRTq + 25 dB
	80 dBA
8 Hz interrupted Duty cycle 25%	SRTq + 25 dB
	80 dBA

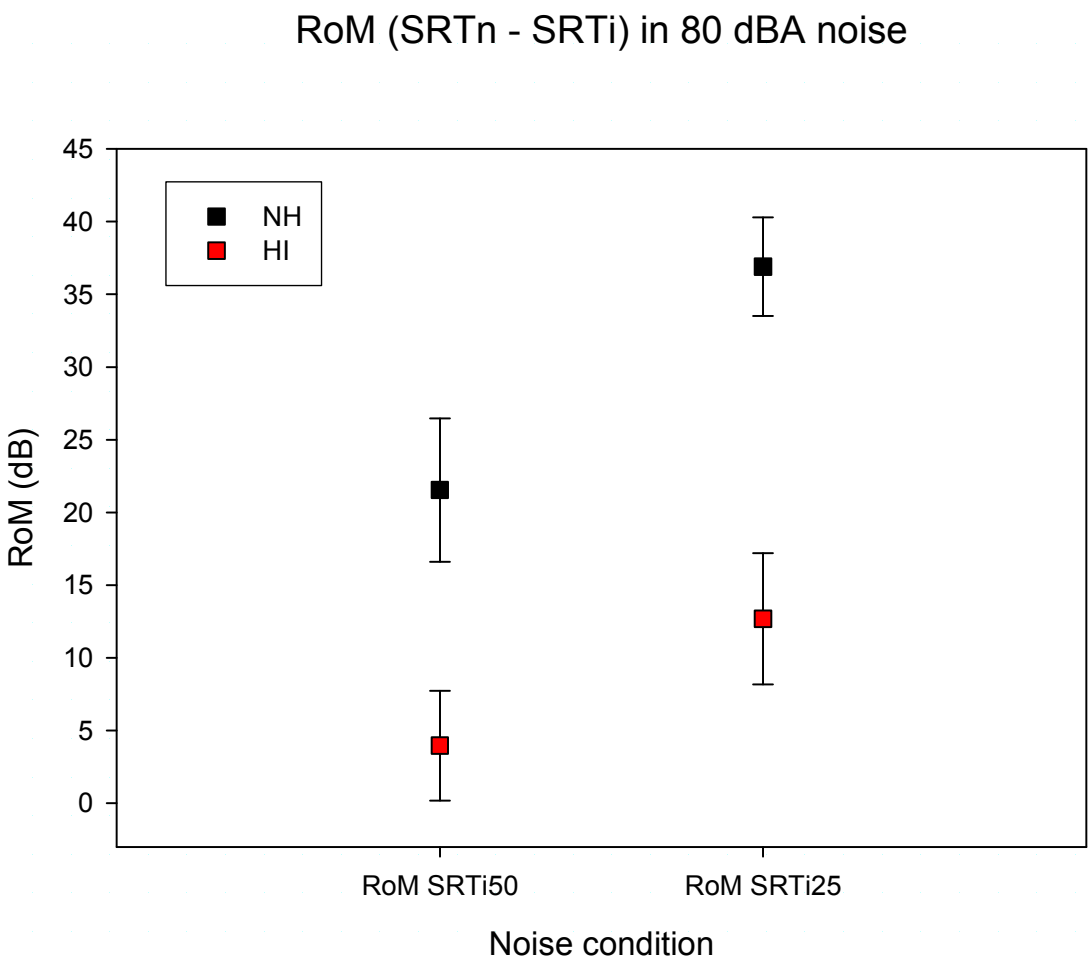


- - 8 NH (HL < 20 dB)
  - 11 HI (HL > 30 dB & SRTq ≤ 60 dBA)
- Two noise levels, to examine intensity dependence
- Two duty cycles, to gather more information on the listener's ability to listen into gaps in noise

Speech Reception Threshold in noise (dB SNR)

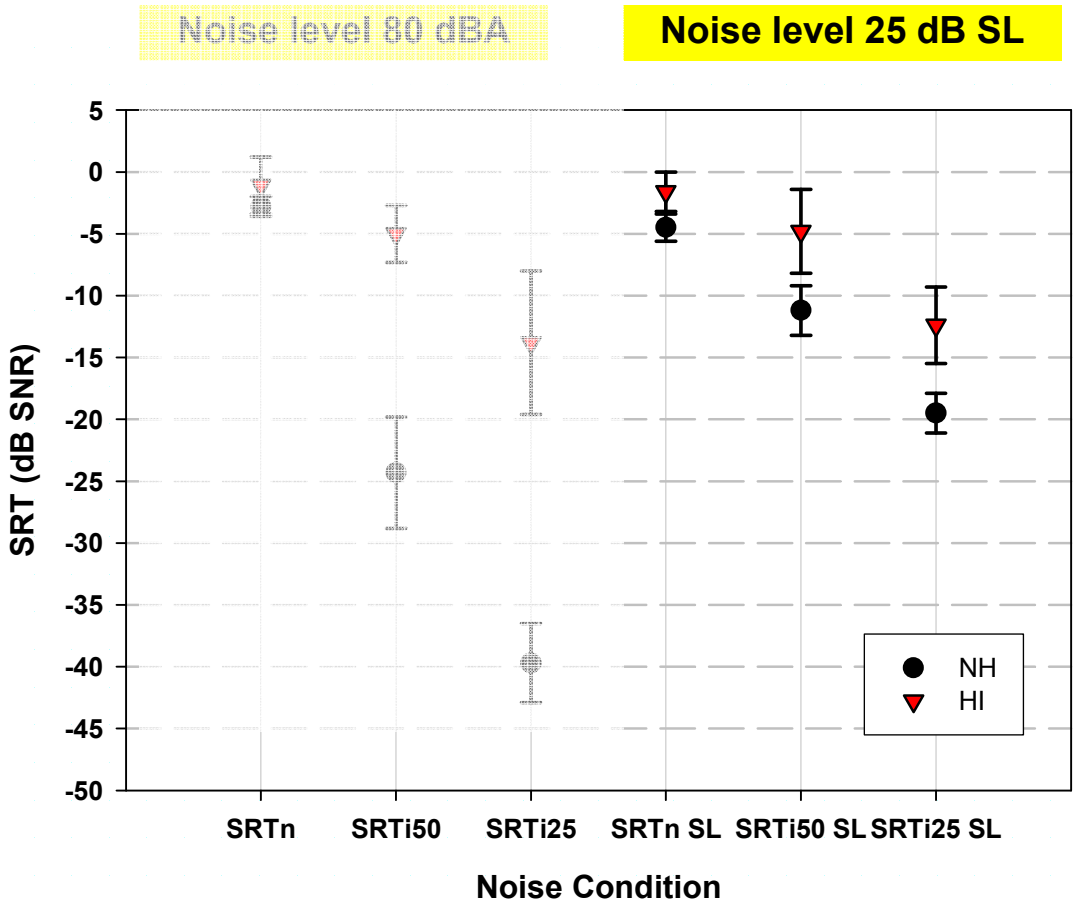


Release of Masking (RoM) in 80 dBA noise



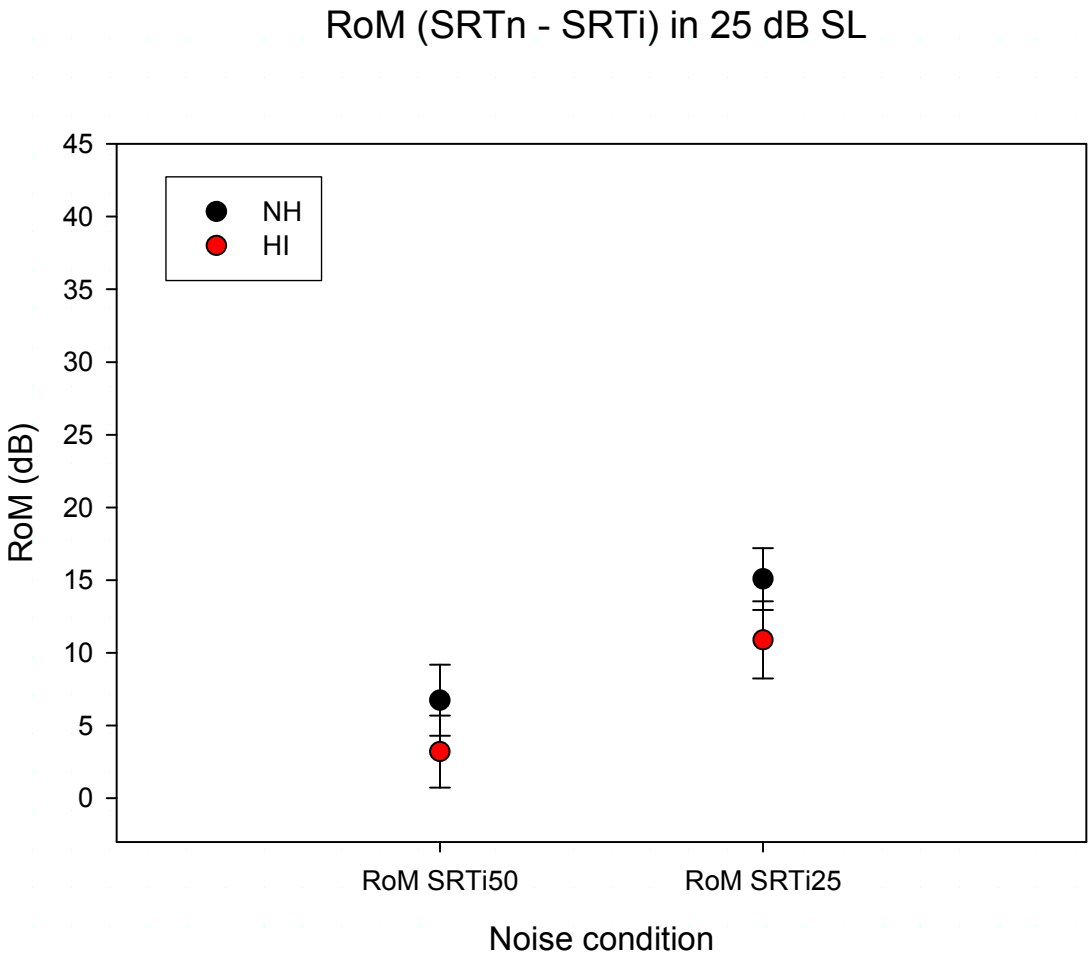
square: 80 dBA noise condition

Speech Reception Threshold in noise (dB SNR)



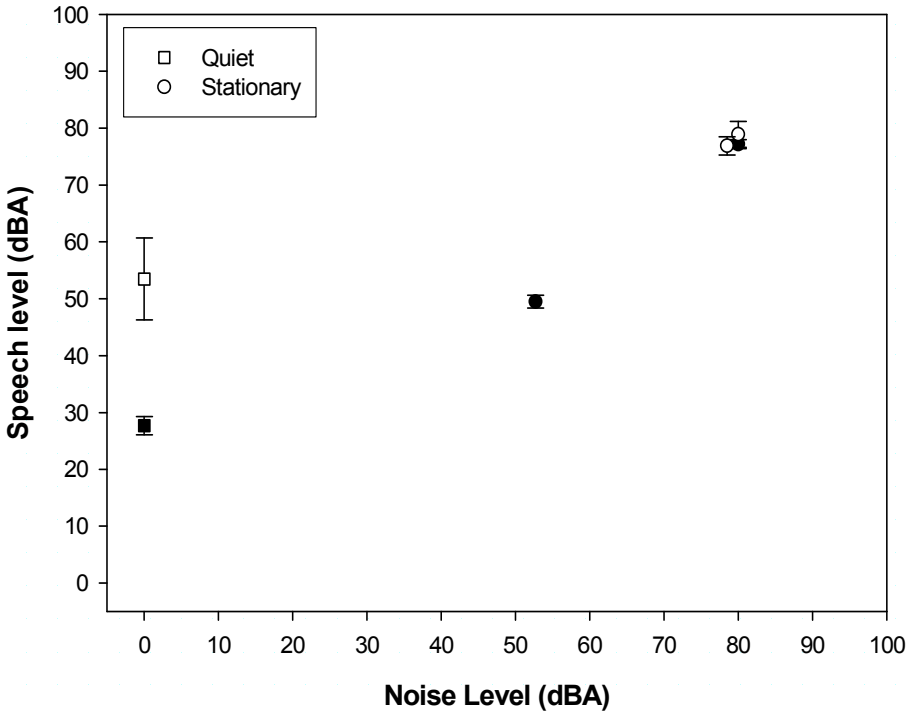
SRTq NH: 28 dB SNR (1.7)
HI: 54 dB SNR (7.2)

Release of Masking (RoM) in 25 dB SL noise



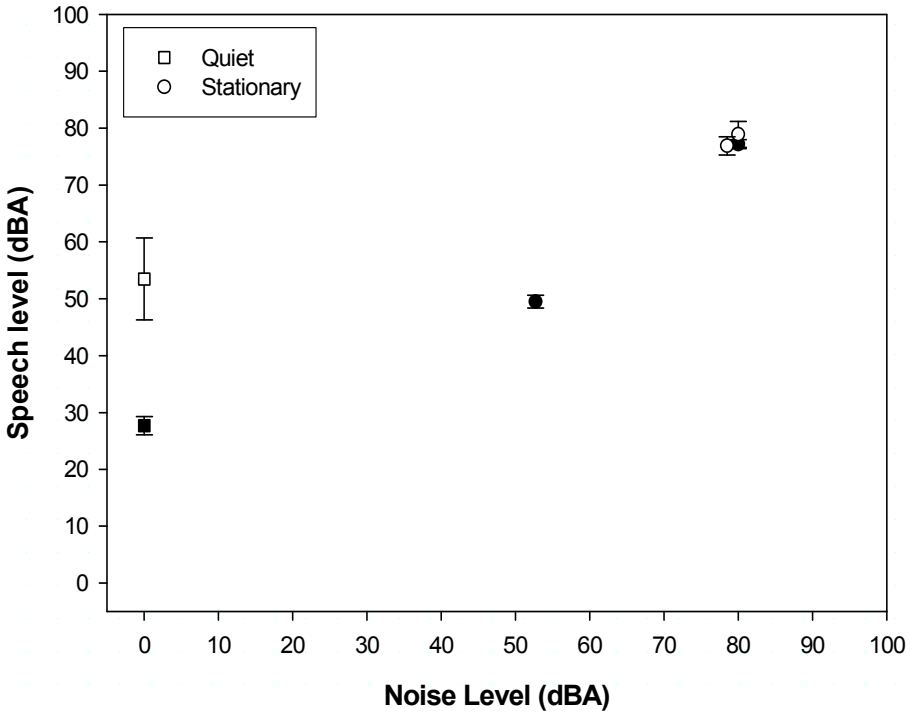
circles: 25 dB SL noise

SRT model (Plomp, 1978)



NH: Black symbol
HI: white symbol

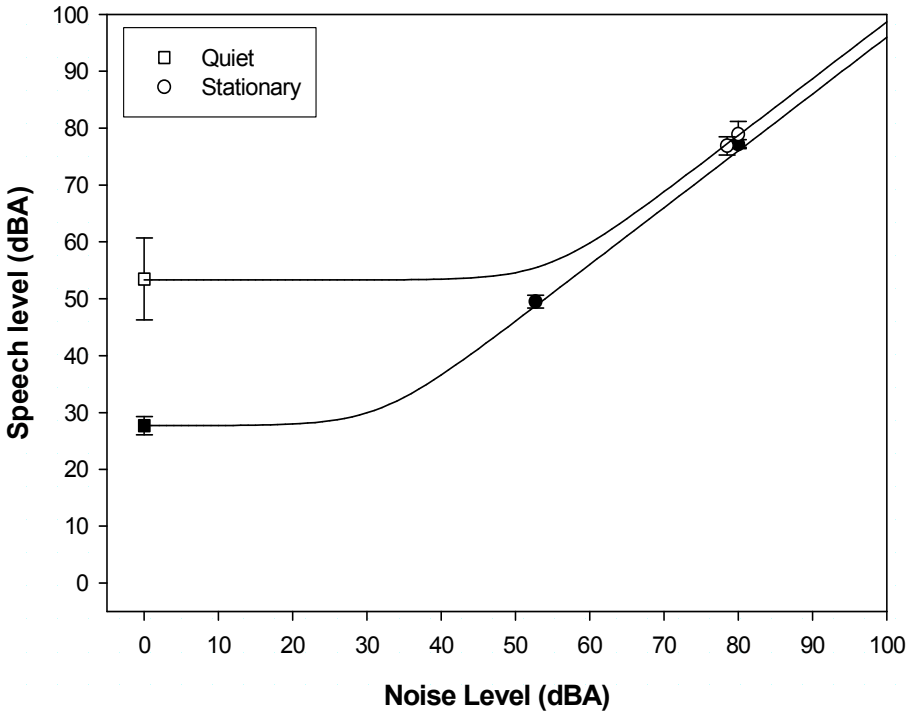
SRT model (Plomp, 1978)



NH: Black symbol
HI: white symbol

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

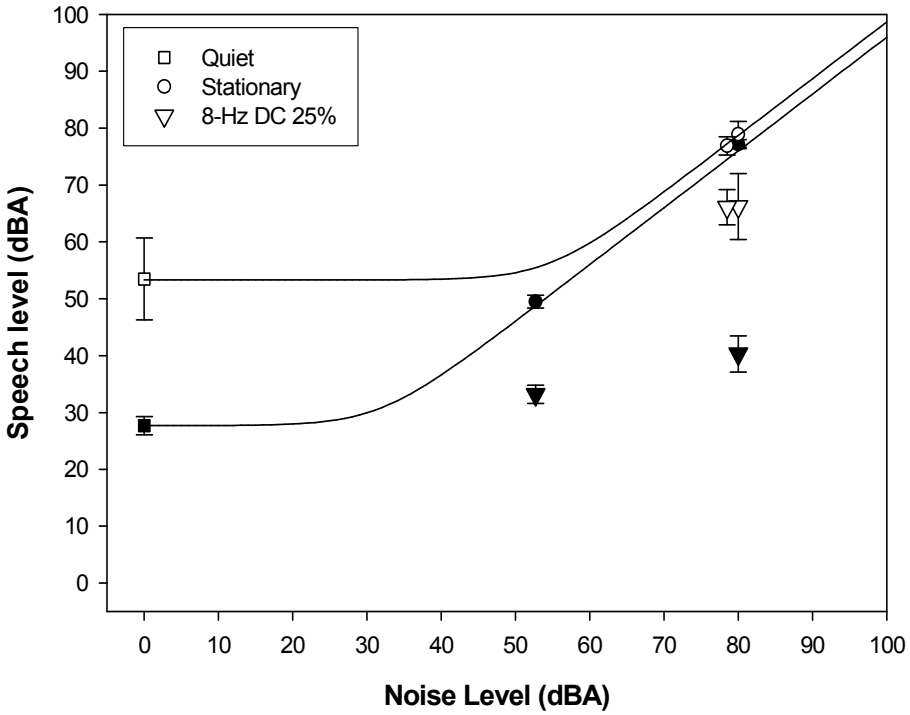
SRT model (Plomp, 1978)



NH: Black symbol
HI: white symbol

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

SRT model (Plomp, 1978)



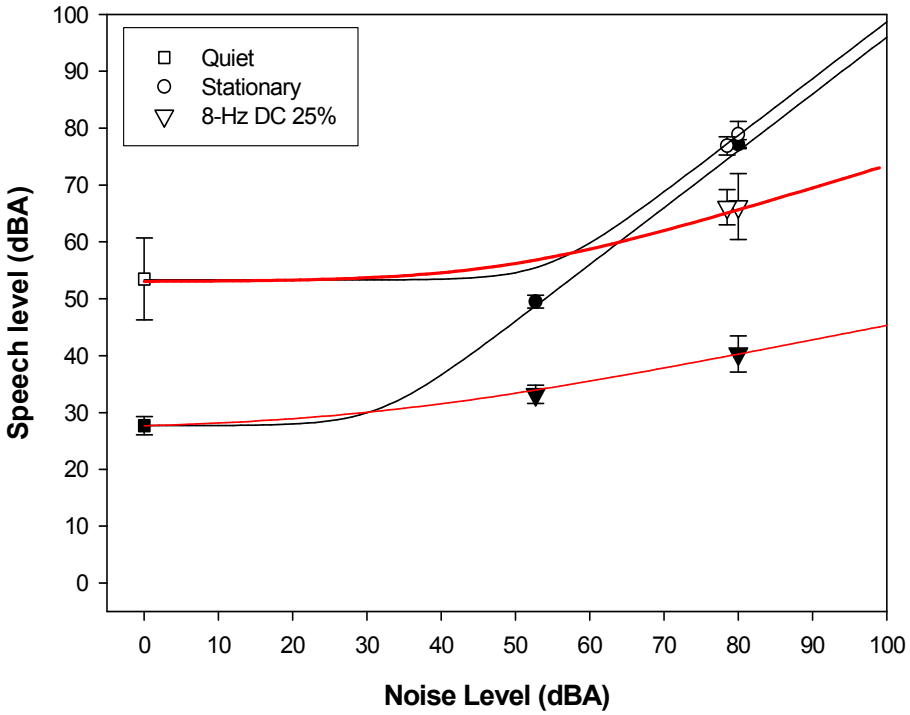
NH: Black symbol
HI: white symbol

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

$$SRT = \alpha + \beta L_N,$$

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(\alpha+(\beta+1)L_N)/10}],$$

Extended SRT model (Rhebergen et al., 200x)



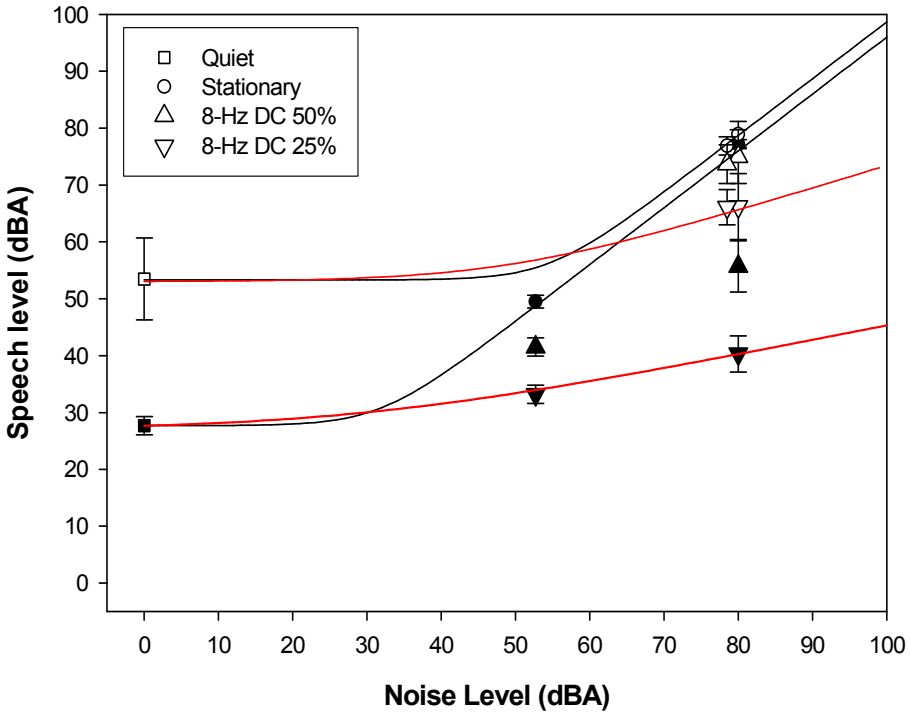
NH: Black symbol
HI: white symbol

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

$$SRT = \alpha + \beta L_N,$$

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(\alpha+(\beta+1)L_N)/10}],$$

Extended SRT model (Rhebergen et al., 200x)



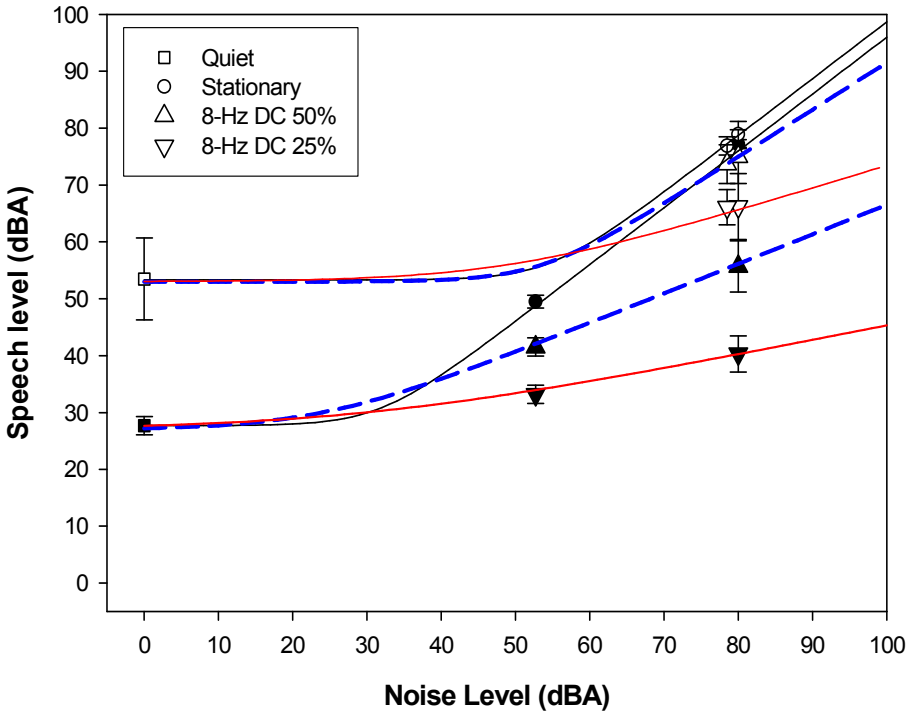
NH: Black symbol
HI: white symbol

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

$$SRT = \alpha + \beta L_N,$$

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(\alpha+(\beta+1)L_N)/10}],$$

Extended SRT model (Rhebergen et al., 200x)



NH: Black symbol
HI: white symbol

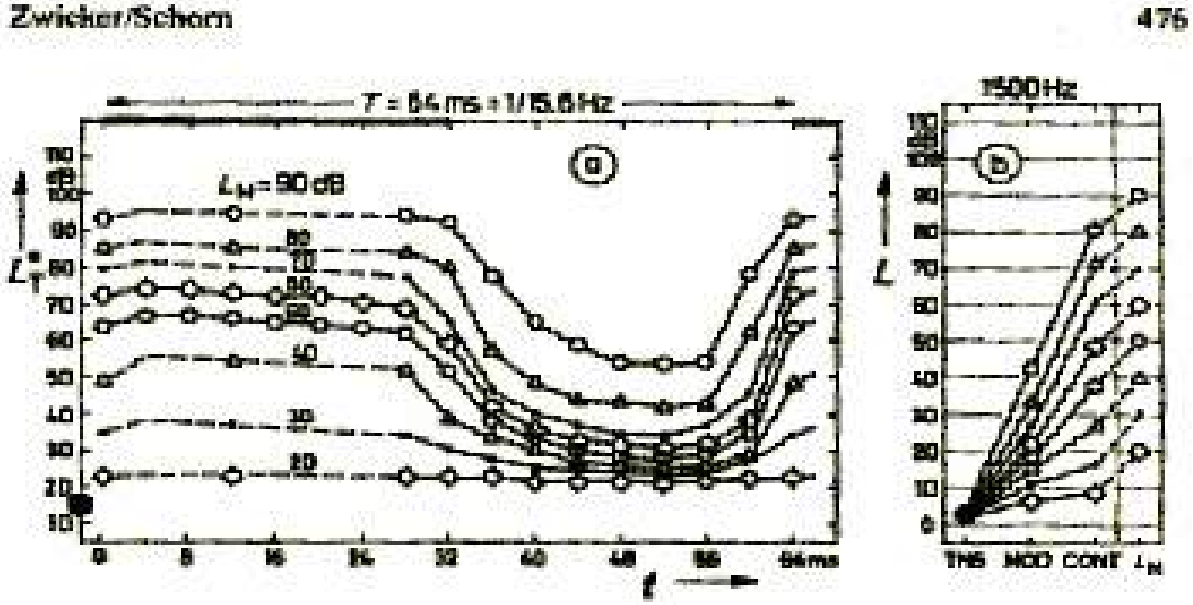
$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(L_N+SRT)/10}],$$

$$SRT = \alpha + \beta L_N,$$

$$L_S = 10\log_{10}[10^{SRT_q/10} + 10^{(\alpha+(\beta+1)L_N)/10}],$$

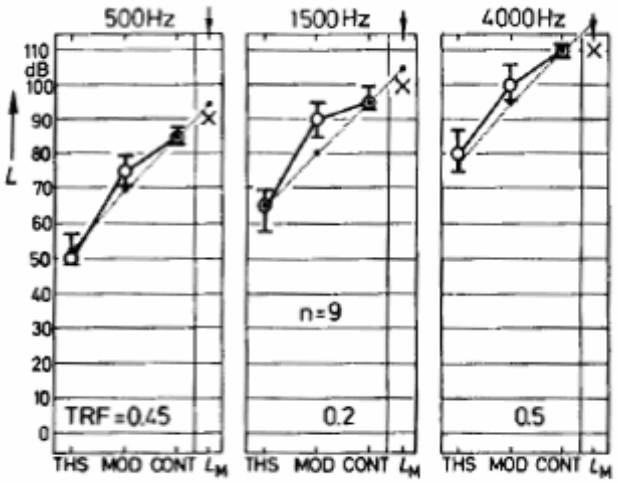
RoM vs Temporal Resolution Factor (TRF)

- As the SRT (dB SNR) in Fluctuating noise is the RoM dependent on the presentation level. Therefore, the RoM might **not** be a good measure to compare the performances for NH & HI listeners at different noise levels



TRF is defined as the ratio between the level differences of the three subjectively measured values; (Zwicker et al 1982)

RoM vs Temporal Resolution Factor (TRF)



Measurement of the listeners hearing threshold in:

- Silence (THS)
- Interrupted (modulated) noise (MOD)
- Continous noise (CONT)

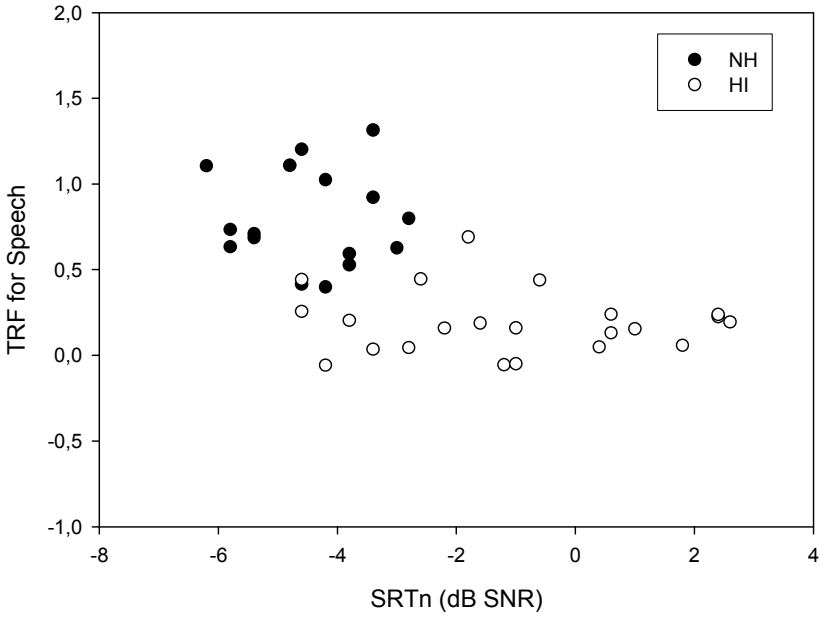
- TRF tone = $(L_{CONT} - L_{MOD}) / (L_{MOD} - L_{THS})$

  (Zwicker et al 1982)

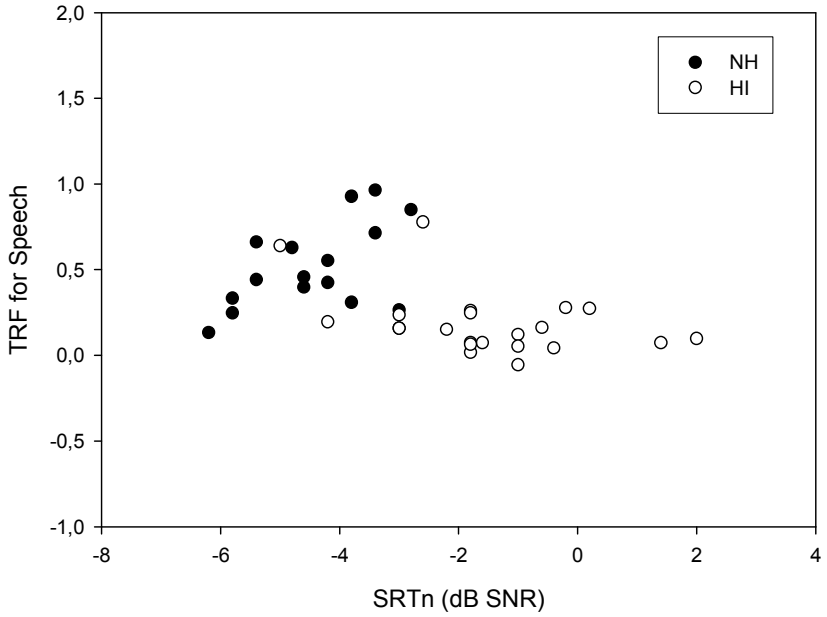
- TRF SRT = $(L_{SRTn} - L_{SRTi}) / (L_{SRTi} - L_{SRTq})$

TRF for Speech vs SRT in stationary noise (SRTn)

TRF for Speech (80 dBA noise)



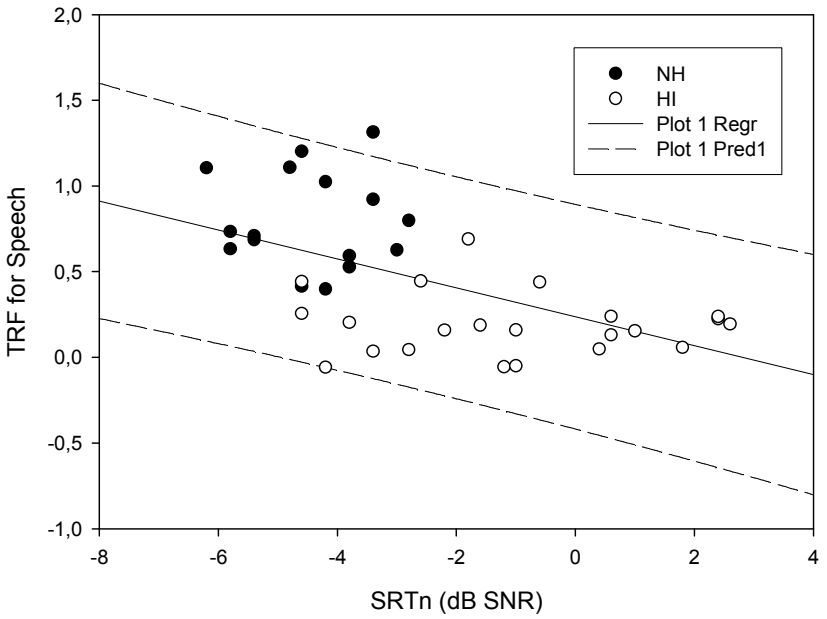
TRF for Speech (SL noise))



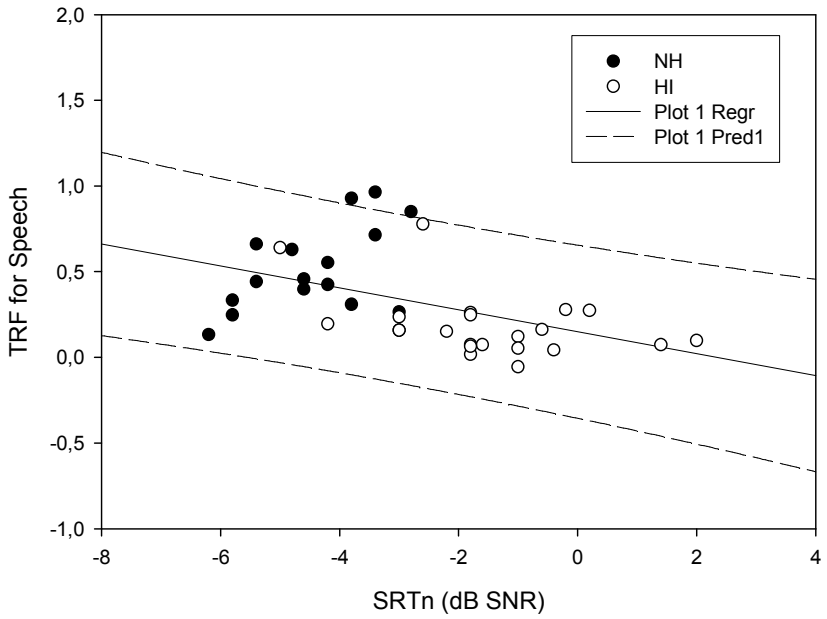
NH: Black symbol
HI: white symbol

TRF for Speech vs SRT in stationary noise (SRTn)

TRF for Speech (80 dBA noise)



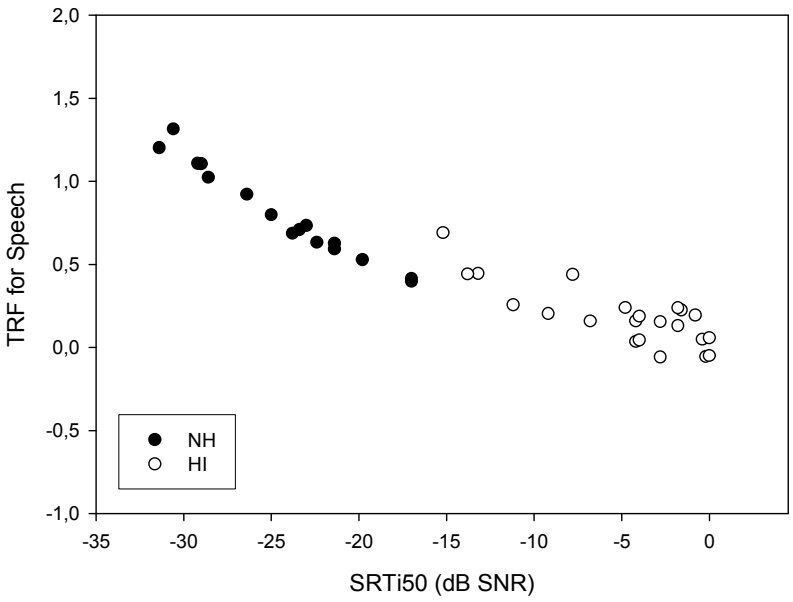
TRF for Speech (SL noise))



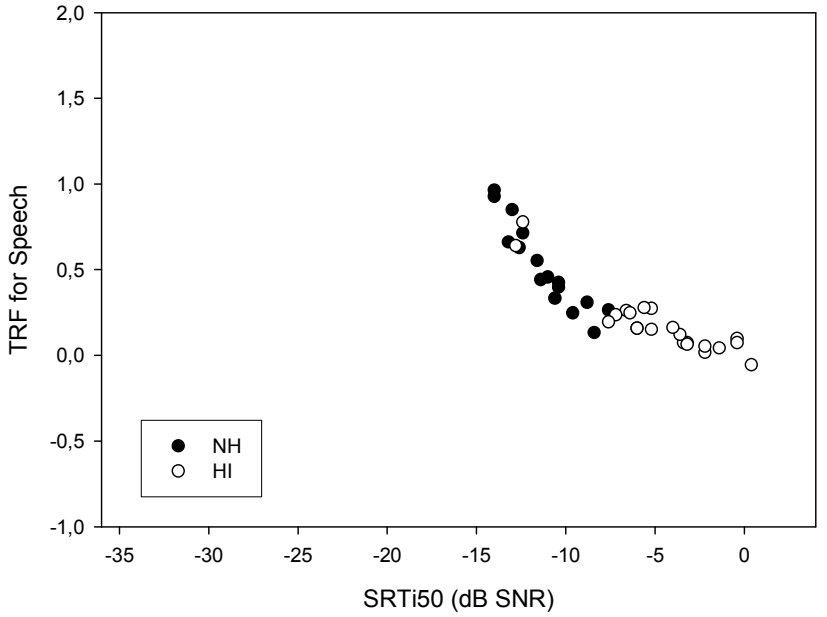
NH: Black symbol
HI: white symbol

TRF for Speech vs SRT in interrupted noise (SRTi50)

TRF for Speech (80 dBA noise)



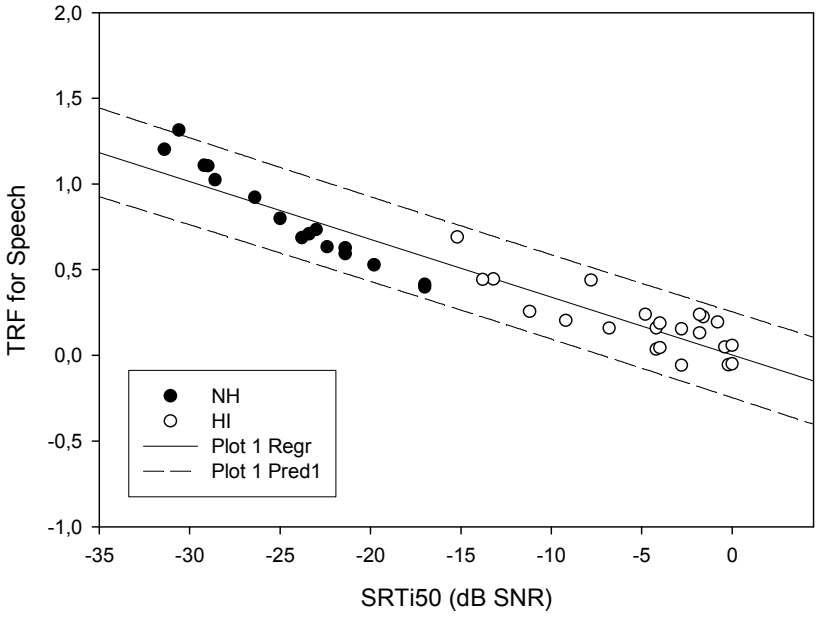
TRF for Speech (SL noise))



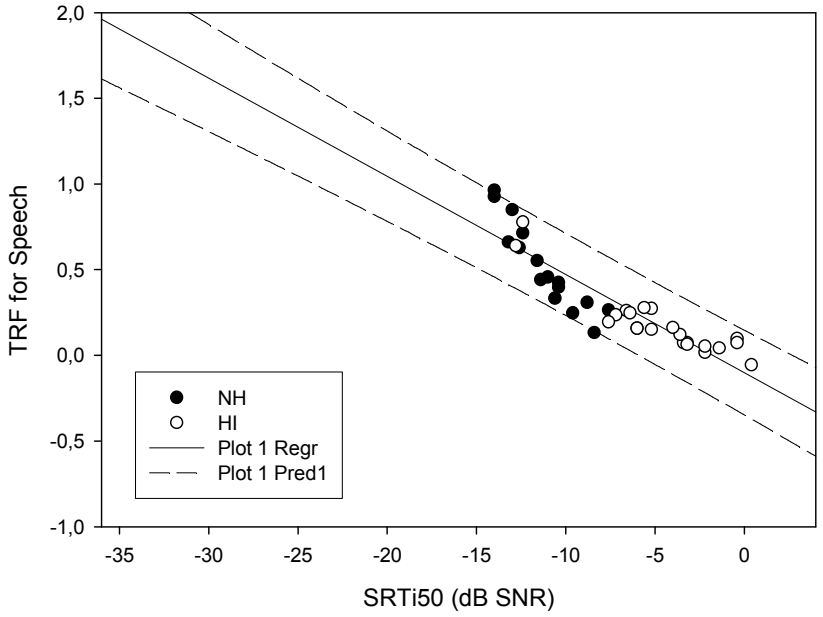
NH: Black symbol
HI: white symbol

TRF for Speech vs SRT in interrupted noise (SRTi50)

TRF for Speech (80 dBA noise)



TRF for Speech (SL noise))

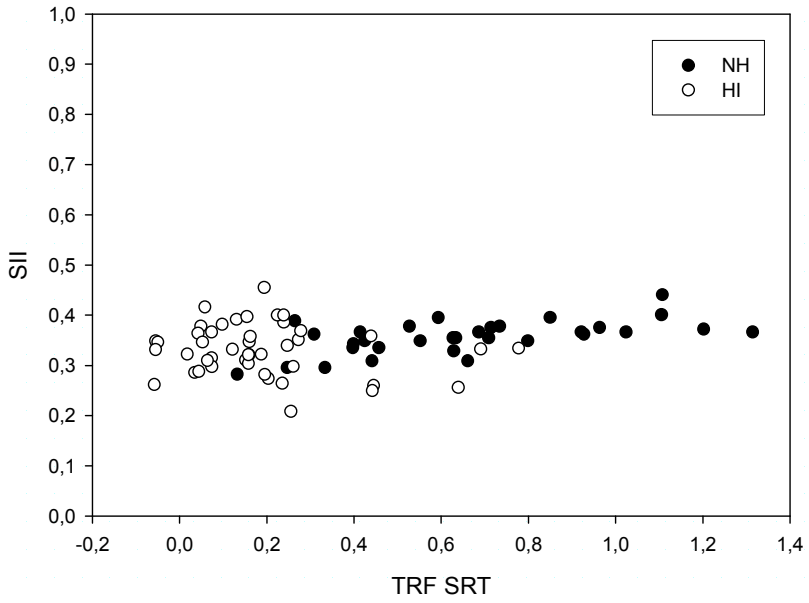


NH: Black symbol
HI: white symbol

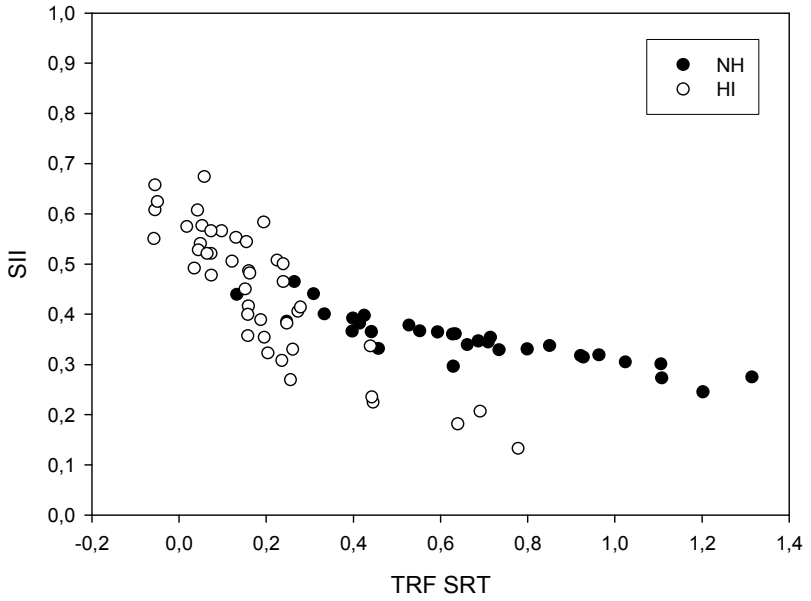
Audibility Calculations

(ESII model Rhebergen, Versfeld & Dreschler, 2006)

SIIn vs TRF SRT



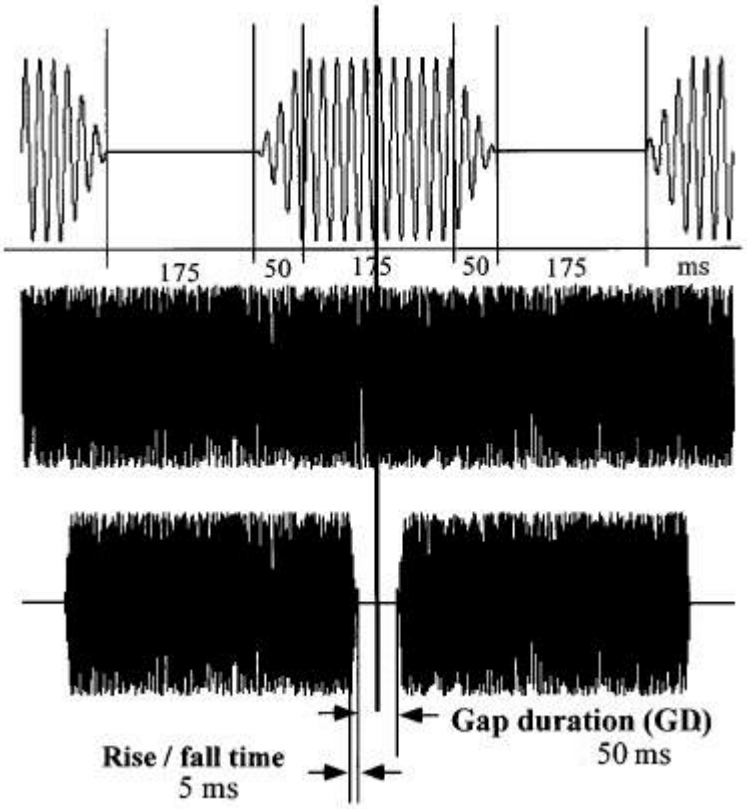
SIIi50 vs TRF SRT



NH: Black symbol
HI: white symbol

Experiment II: temporal resolution

- Masking period patterns (Zwicker and Schorn, 1980)
  Up-down method

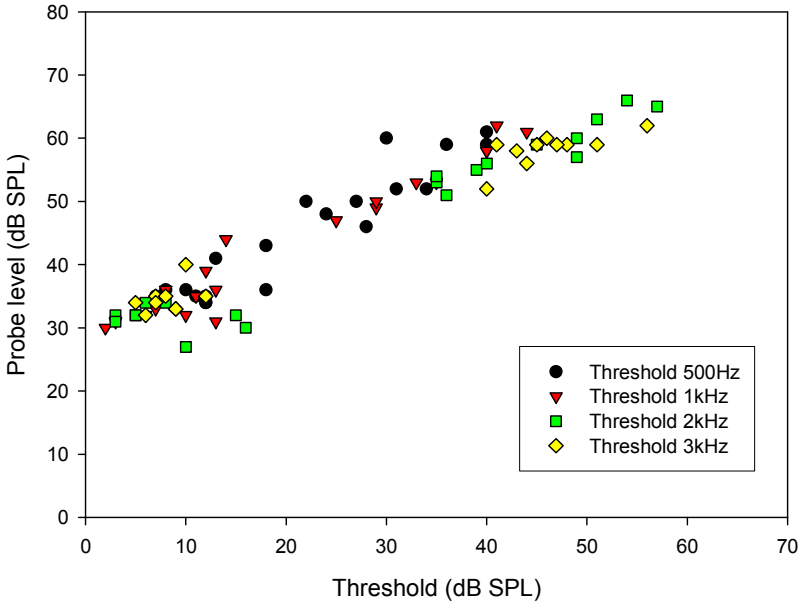


- **Noise level** 70 dB SPL
- **Frequency**: 0.5 1, 2 & 3 kHz

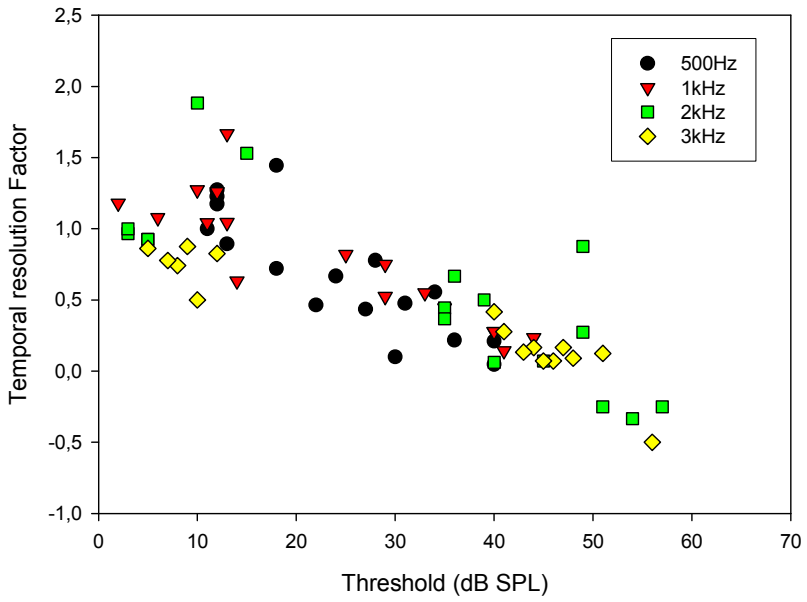
- TRF tone = $(L_{CONT} - L_{MOD}) / (L_{MOD} - L_{THS})$
  (Zwicker et al 1982)

Threshold vs TRF

threshold vs probe level



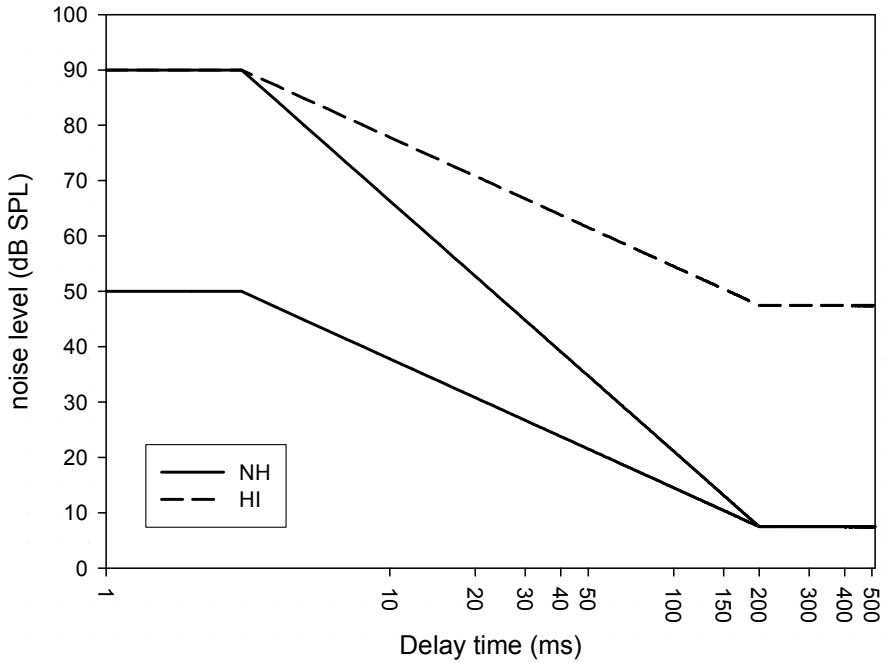
threshold vs Temporal Resolution Factor



Modeling threshold probe level

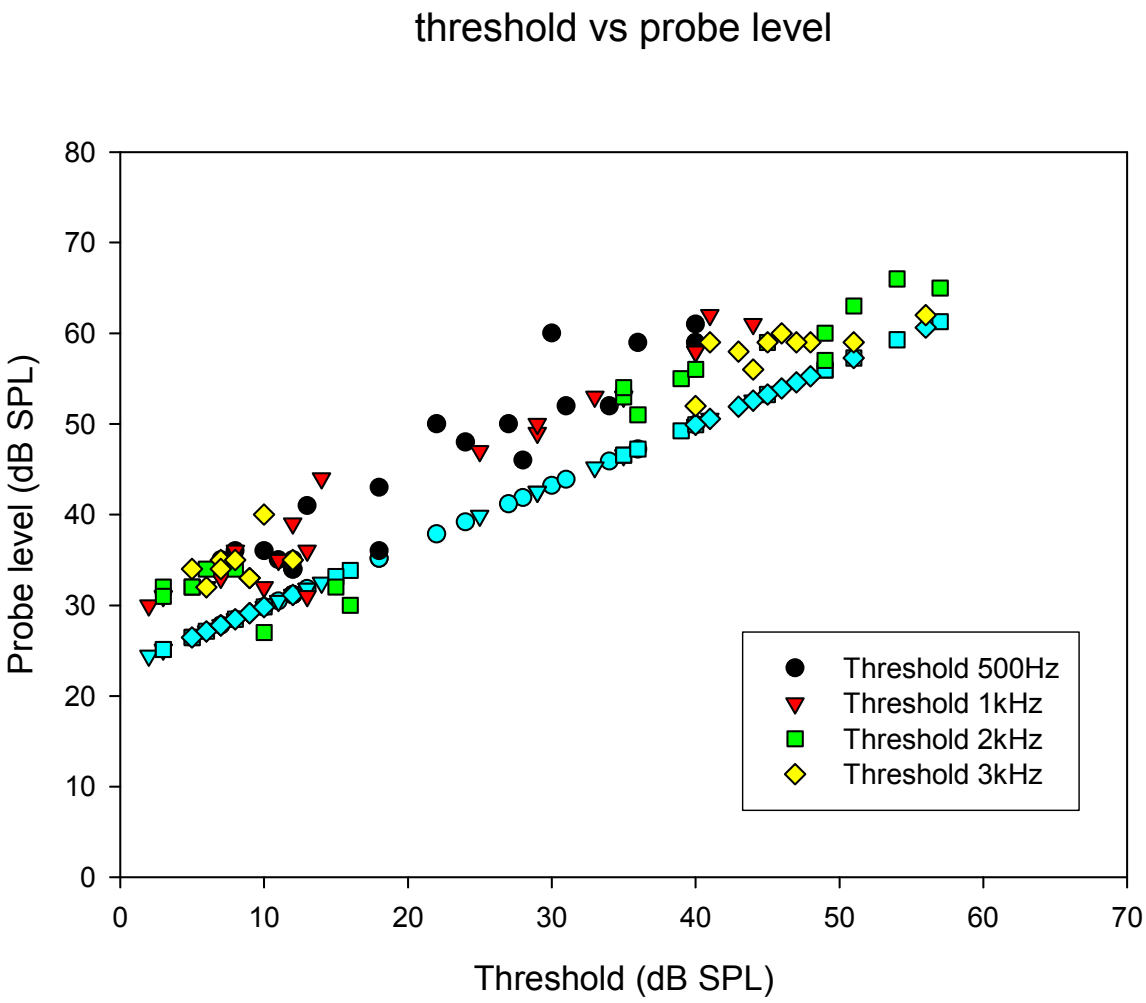
Ludvigsen (1985)

Ludvigsen 85



$$E_{FMF}(t) = E(T_0) - \frac{\log(t / T_0)}{\log(T_f / T_0)} * [E(T_0) - E(T_f)],$$

Observed vs Predicted probe level



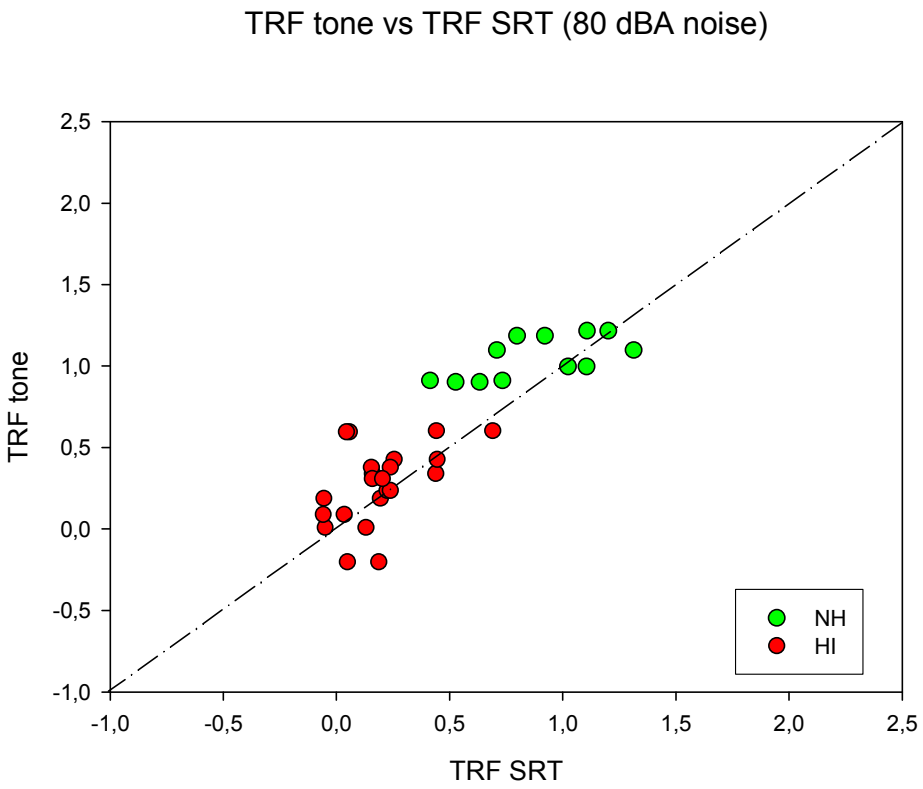
Correlations

Ludvigsen: 0.962 ($p < 0.001$)

Frequency	Mean	Std. Deviation
500 Hz	-7,5	3,8
1 kHz	-6,5	2,8
2 kHz	-4,3	3,3
3 kHz	-4,9	2,4
Total	-5,8	3,3

TRF tone vs TRF SRT

NH: Green symbol
HI: Red symbol



Average TRF value (0.5, 1, 2 & 3 kHz)

Conclusions

- At equal sensation level is the SRT in modulated noise in NH listeners on average lower (better) than the SRT in HI Listeners.
- There *seems* to be a relation between the TRF for tone & the TRF for speech (SRT)
- HI listeners *seems* to need more audible speech (i.e. higher SII value) in modulated noise for the observed SRT than in stationary noise

Fin

End

Ende

Einde