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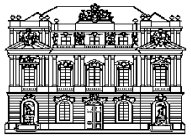

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Interaural Time Differences in Ongoing and Gating Signal Portions in Acoustic and Electric Hearing: Model Results

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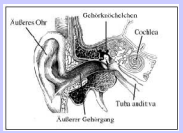

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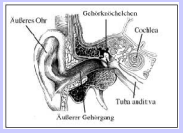
Contents

- Problem: Ongoing and Gating Interaural Time Differences (ITD) in pulse trains
- Experiments with Normal Hearing (NH) and Cochlear Implant (CI) listeners
  - Pulse rate
  - ITD type
  - Duration
- A „multiple looks“ lateralization model
- Evaluation of the model
- Summary and conclusions



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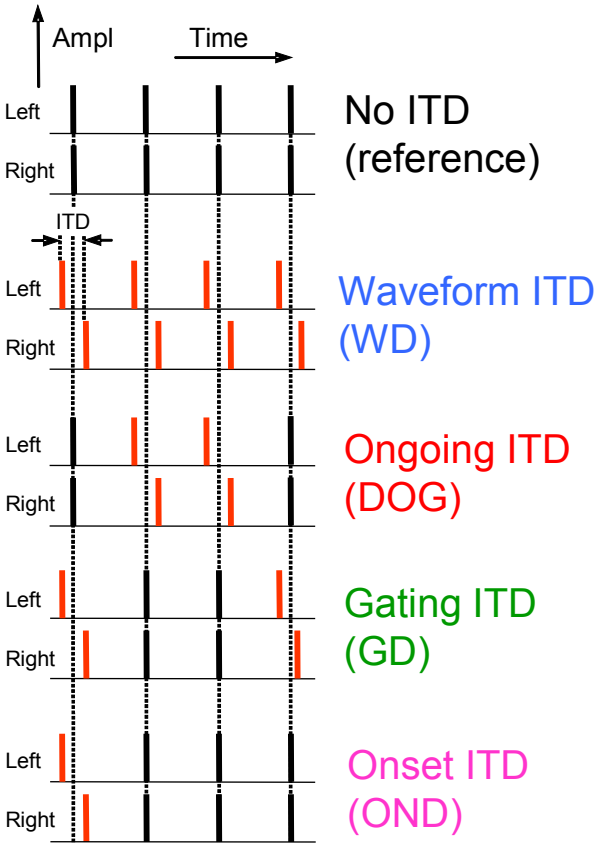
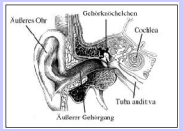
Interaural Time Differences

- CI listeners sensitive to ITD in pulse train (e.g. van Hoesel et al., 2003)
- Contribution of ongoing and gating ITD not known
- Sensitivity to ongoing ITD implies relevance of pulse timing („fine structure“) for stimulation strategies





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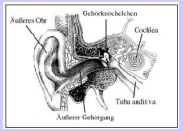
Experiment

- JNDs for Lateralization Discrimination
  - 2-interval, 2-AFC
  - Response feedback
- Subjects & Stimuli
  - Five NH listeners: bandpass-filtered clicks
  - Three CI listeners (*C40+*, *MED-EL*): electric pulses
- Independent Variables:
  - ITD condition
  - Pulse Rate
  - Duration



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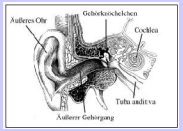
Modelling

- Classical Cross-correlation model not satisfying:
  - Does not explain onset dominance
  - Does not explain temporal integration of ITD
- "Multiple Looks" Lateralization model more promising:
  - Allows variable weighting of different signal portions (Lindemann, 1986; Akeroyd and Bernstein, 2001)
  - Allows modeling of temporal integration



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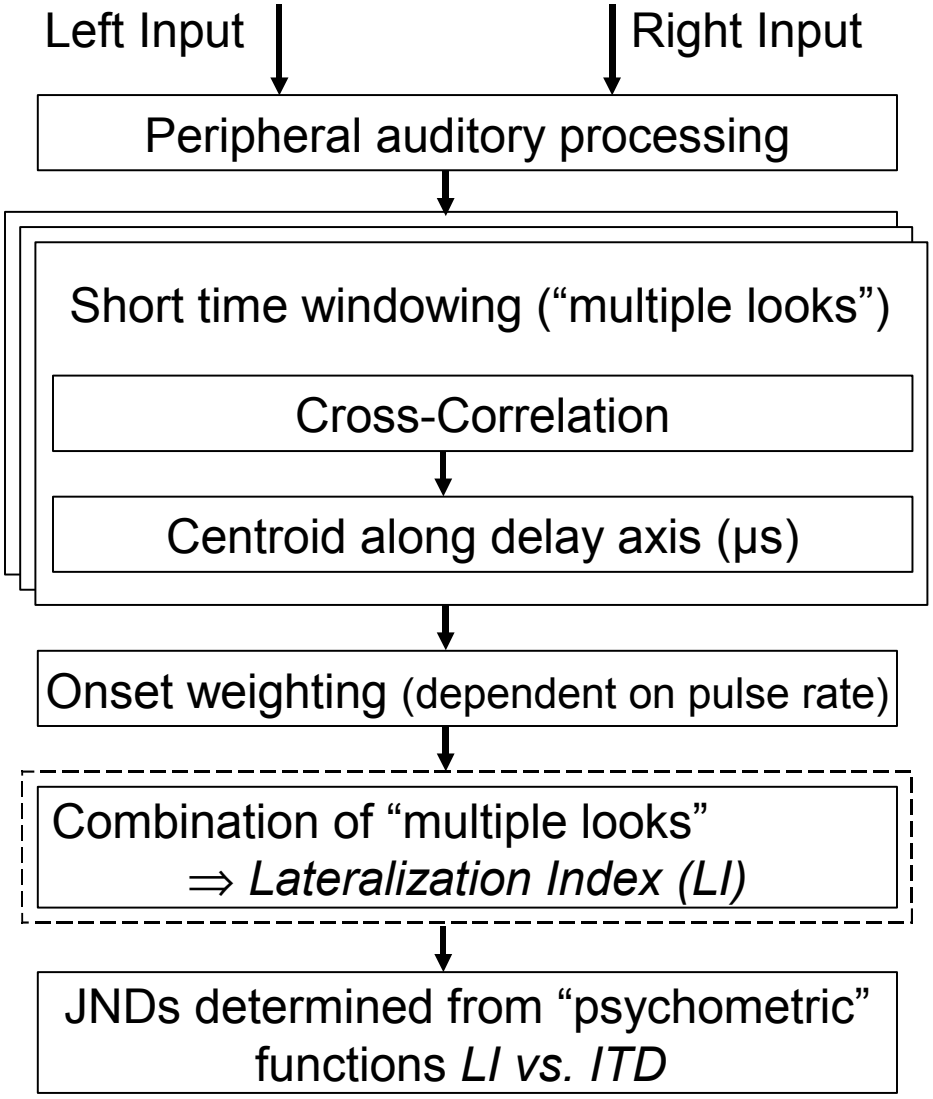
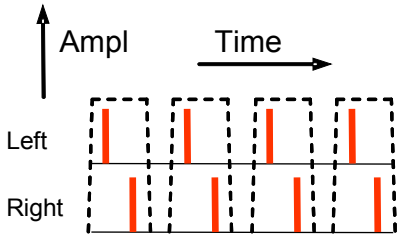
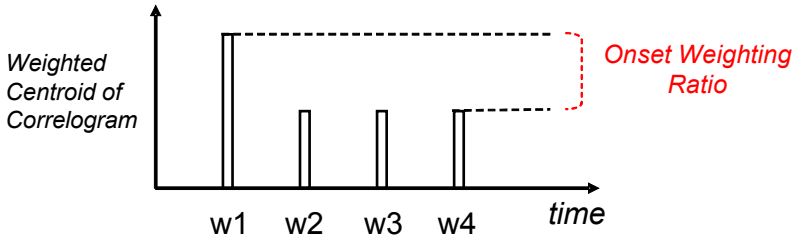
A "Multiple Looks" Lateralization Model







Saberi (1996)
Stecker and Hafter (2002)

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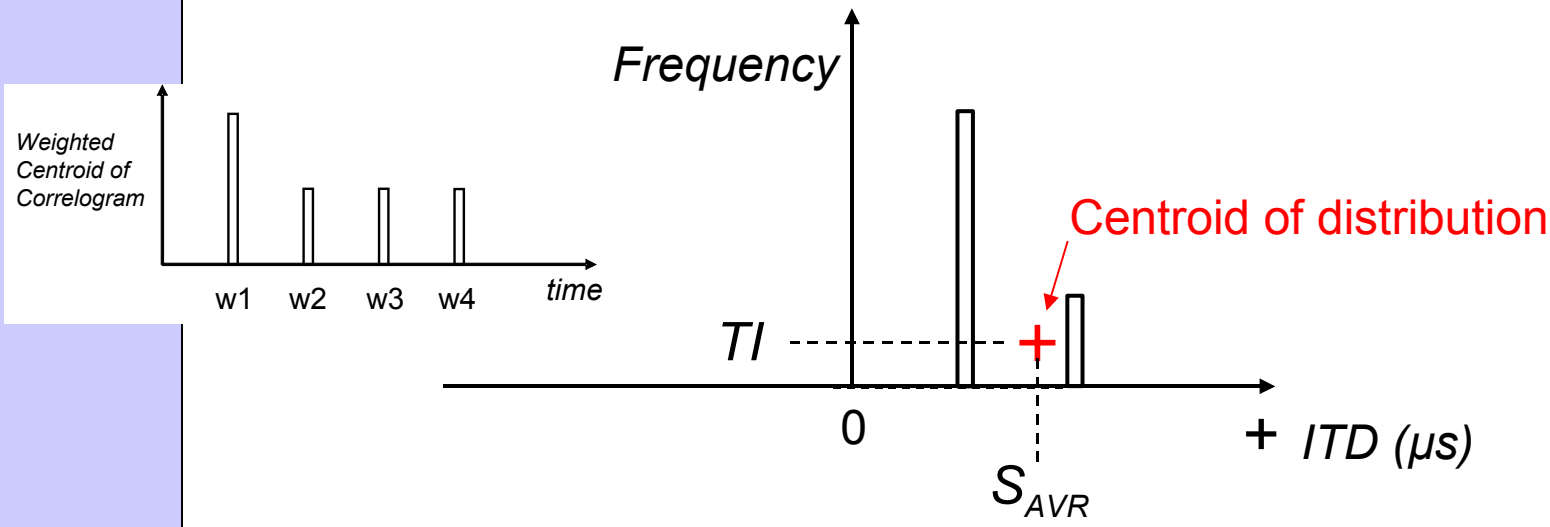
Lateralization Index (LI)

Histogram of weighted centroid values



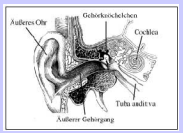
$$LI = S_{AVR} \cdot TI^{k}$$

S_{AVR} → average sidedness

TI → temporal integration

k → efficiency of temporal integration

k = 0.5 → optimal integration



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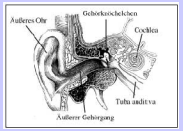
Evaluation of the model

- Model Input:
  - Acoustic stimuli (also in case of CI listeners' data)
  - Observed JNDs
- Model Output:
  - Predicted JNDs best fitting the observed JNDs



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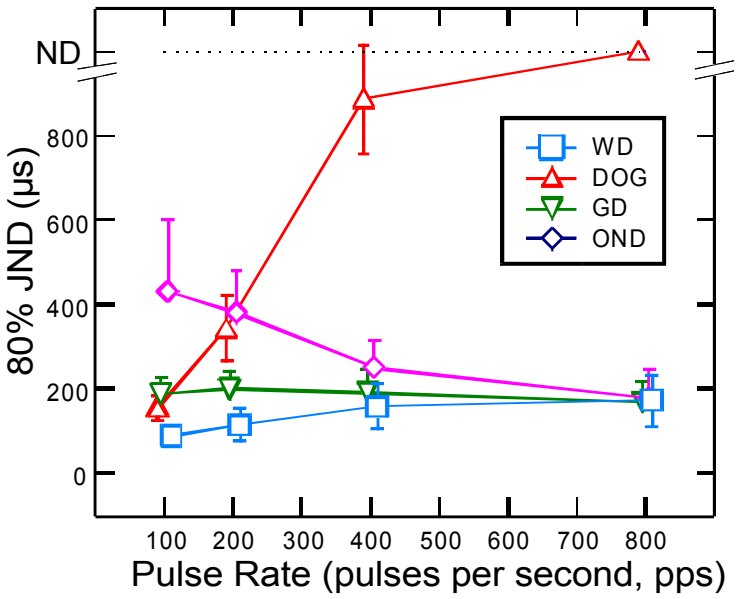
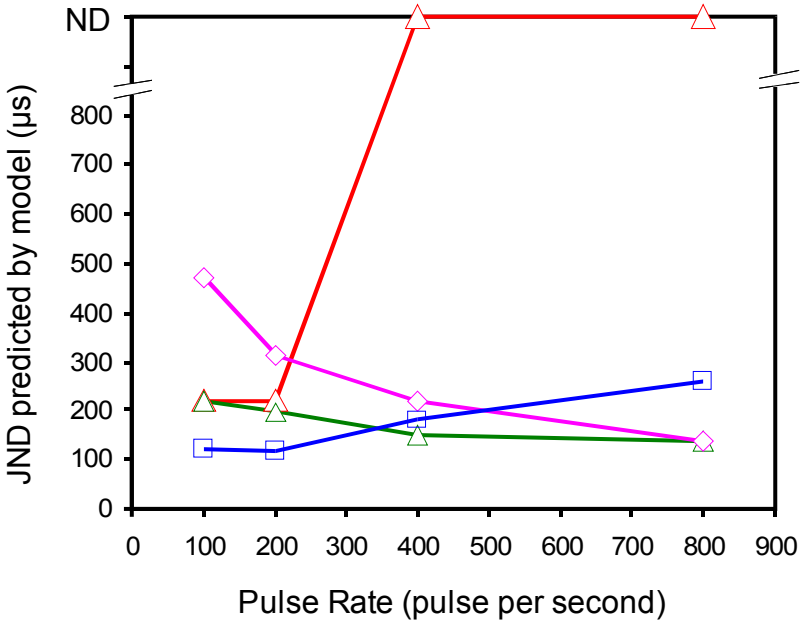
Observed & Model Results: Four-Pulse Stimuli

NH listeners

Observed JNDs



Predicted JNDs

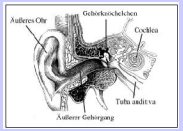


Optimized model parameters:

-*Onset Weighting function*

-Window duration

} Variance explained: **89%**



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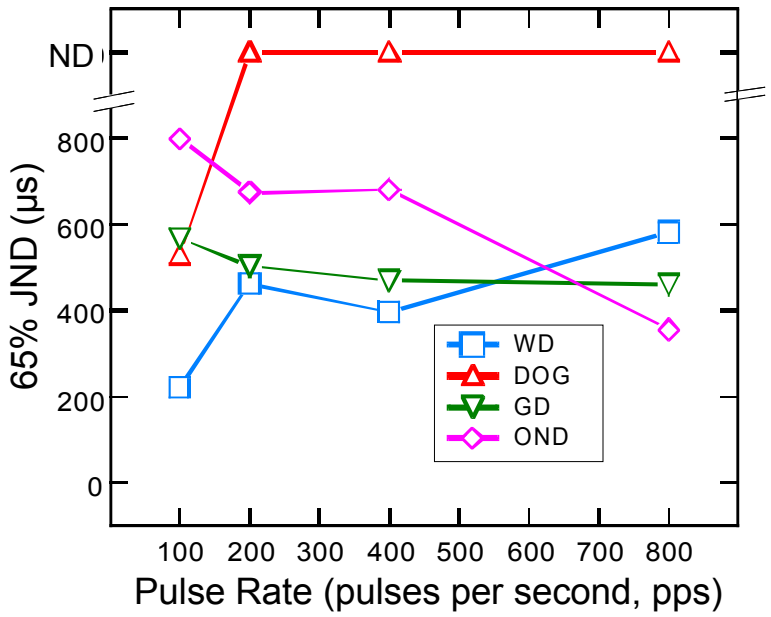
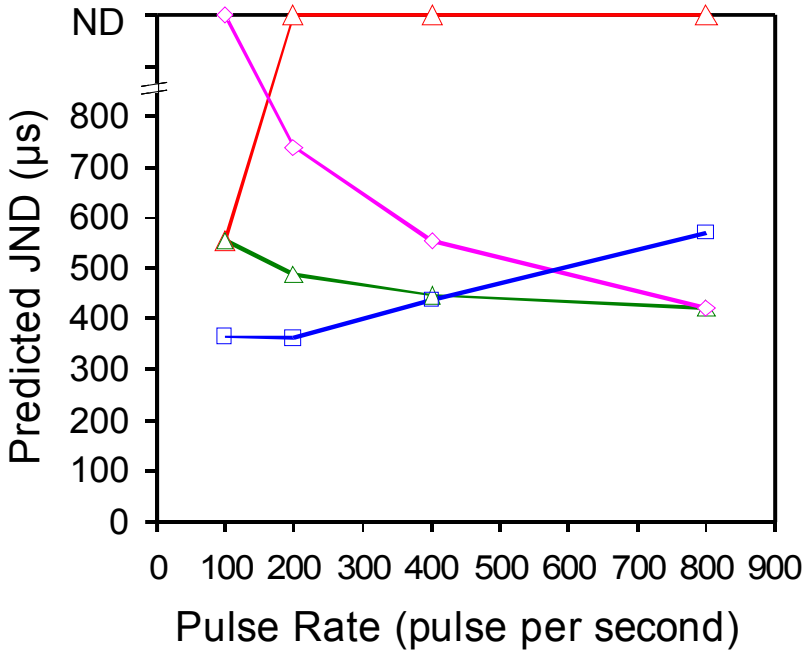
Observed & Model Results: Four-Pulse Stimuli

CI listener CI1

Observed JNDs

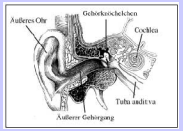


Predicted JNDs



Same model parameters as with NH listeners

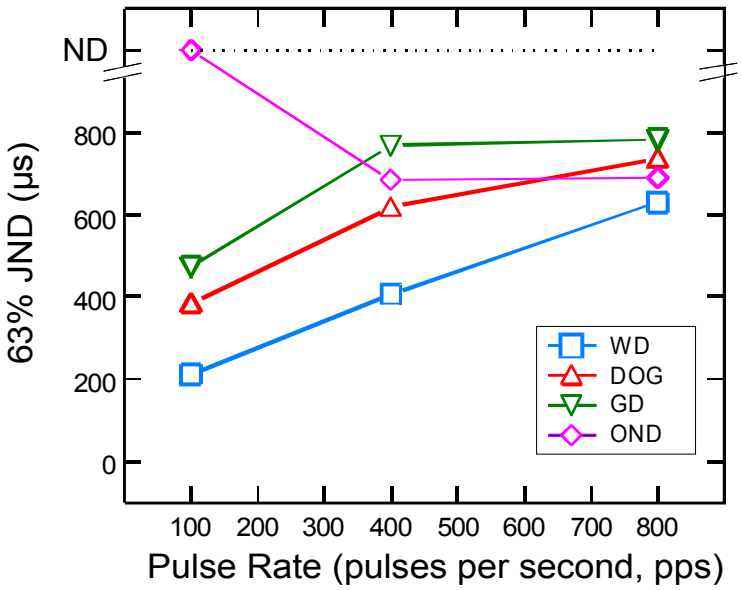
Variance explained: **68%**



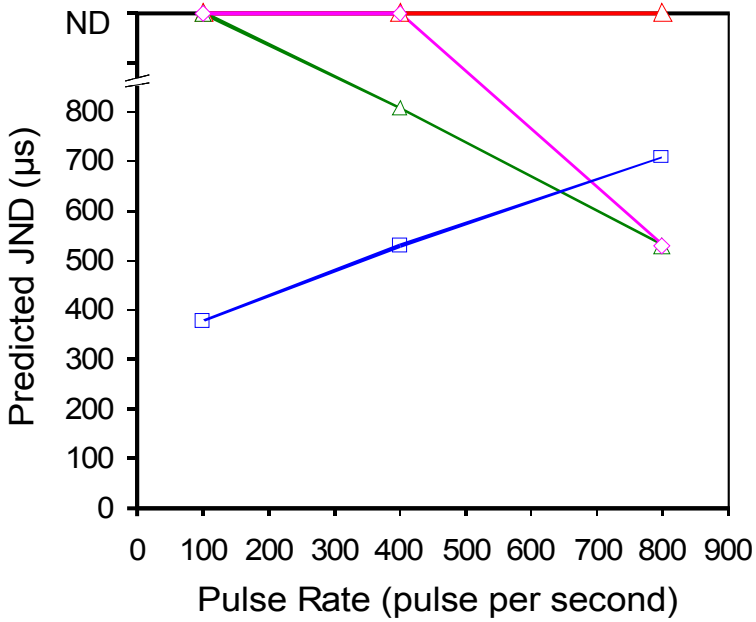
Observed & Model Results: Four-Pulse Stimuli

CI listener CI8

Observed JNDs

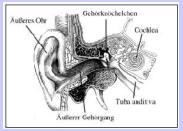


Predicted JNDs



Same model parameters as with NH listeners

Variance explained: **45%**



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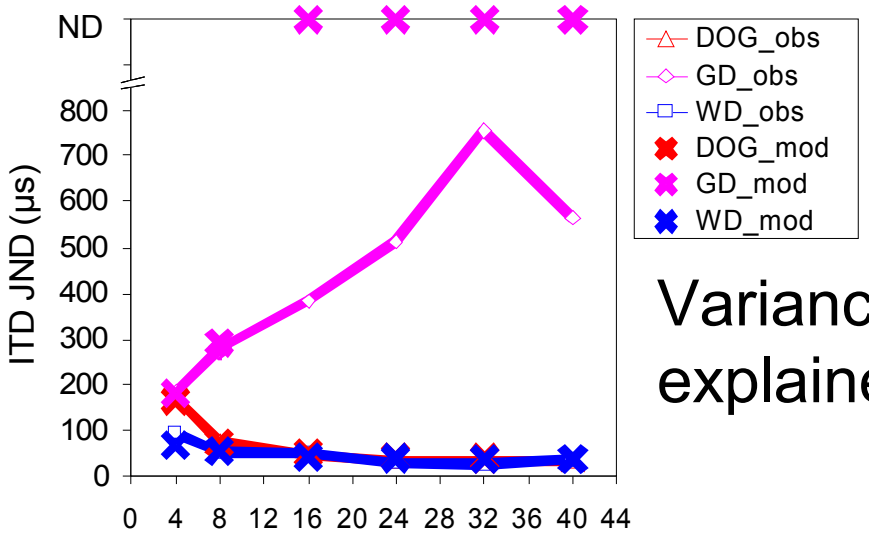
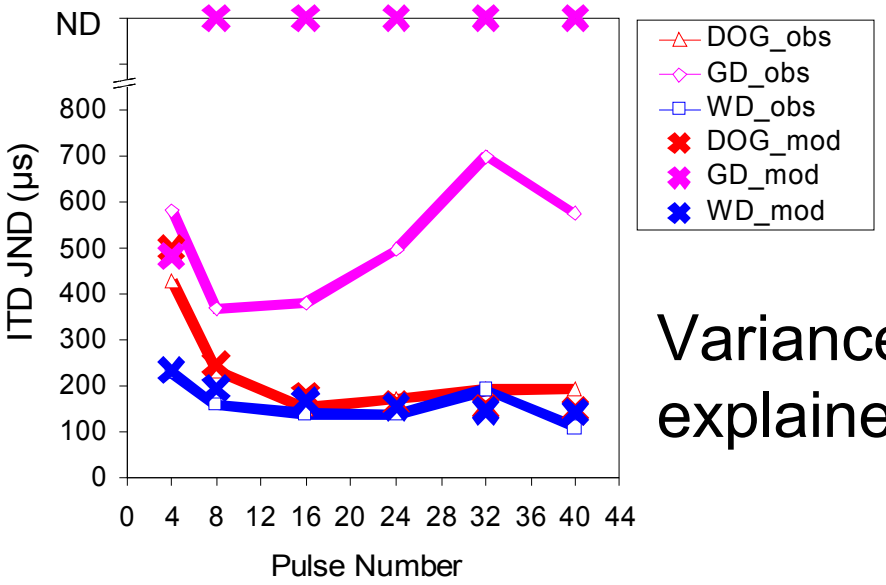
Observed & Model Results: Effect of Duration 100 pulses per second

Mean **NH** listeners (n=4)

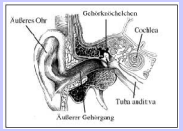


Variance explained: **98%**

Mean **CI** listeners (n=3)



Variance explained: **90%**



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Summary & Conclusions

- Experiments
  - CI listeners are sensitive to ongoing ITD (upper rate limit: 100-800 pps)
    → Fine structure coding in stimulation strategies
  - Onset dominance increases with pulse rate

- "Multiple looks" lateralization model
  - NH listeners
    - Model accounts well for the observed effects (ITD type, pulse rate, and duration)
  - CI listeners (no modeling of peripheral processing)
    - One subject: model explains effects of ITD type and pulse rate
    - All subjects: good account for effects of duration