



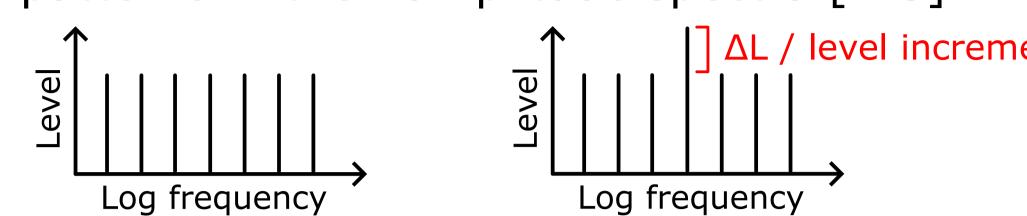
Profile analysis in listeners with sensorineural hearing loss

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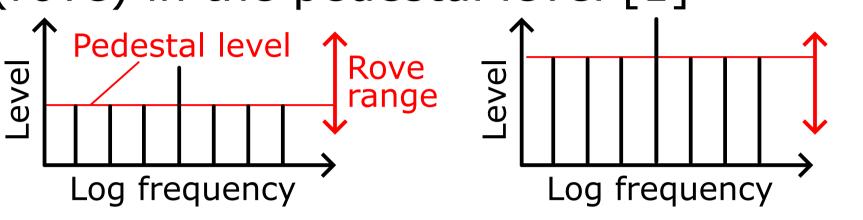


Introduction

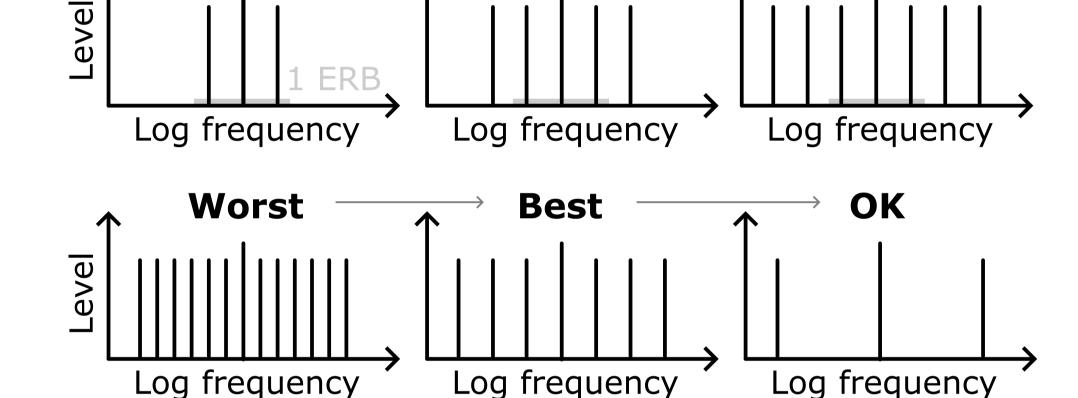
Profile analysis is the ability of listeners to discriminaté between sounds based_on patterns in their amplitude spectra [1-5]



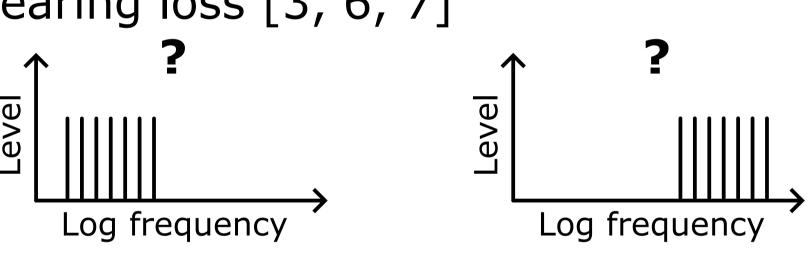
Profile analysis is robust to random variation (rove) in the pedestal level [1]



Thresholds depend on component count, spacing, and spectral distribution [2-5]



Some effects are less well understood, including effects of frequency range and hearing loss [3, 6, 7]



Methods

Stimuli

Sine-phase log-spaced complex tones

Components spanning from 0.2× to 5× target frequency (0.5, 1, 2, or 4 kHz)

Variable number of components (5, 13, 21, 29, or 37)

Overall masker level (w/o level increment): 70 dB SPL (fixed-level condition) or 60-80 dB SPL (roved-level condition)

200-ms duration

Participants

21 participants (21–77 years of age)

Wide range of hearing loss (-3 to 57 dB HL, PTA over 0.25-8 kHz)

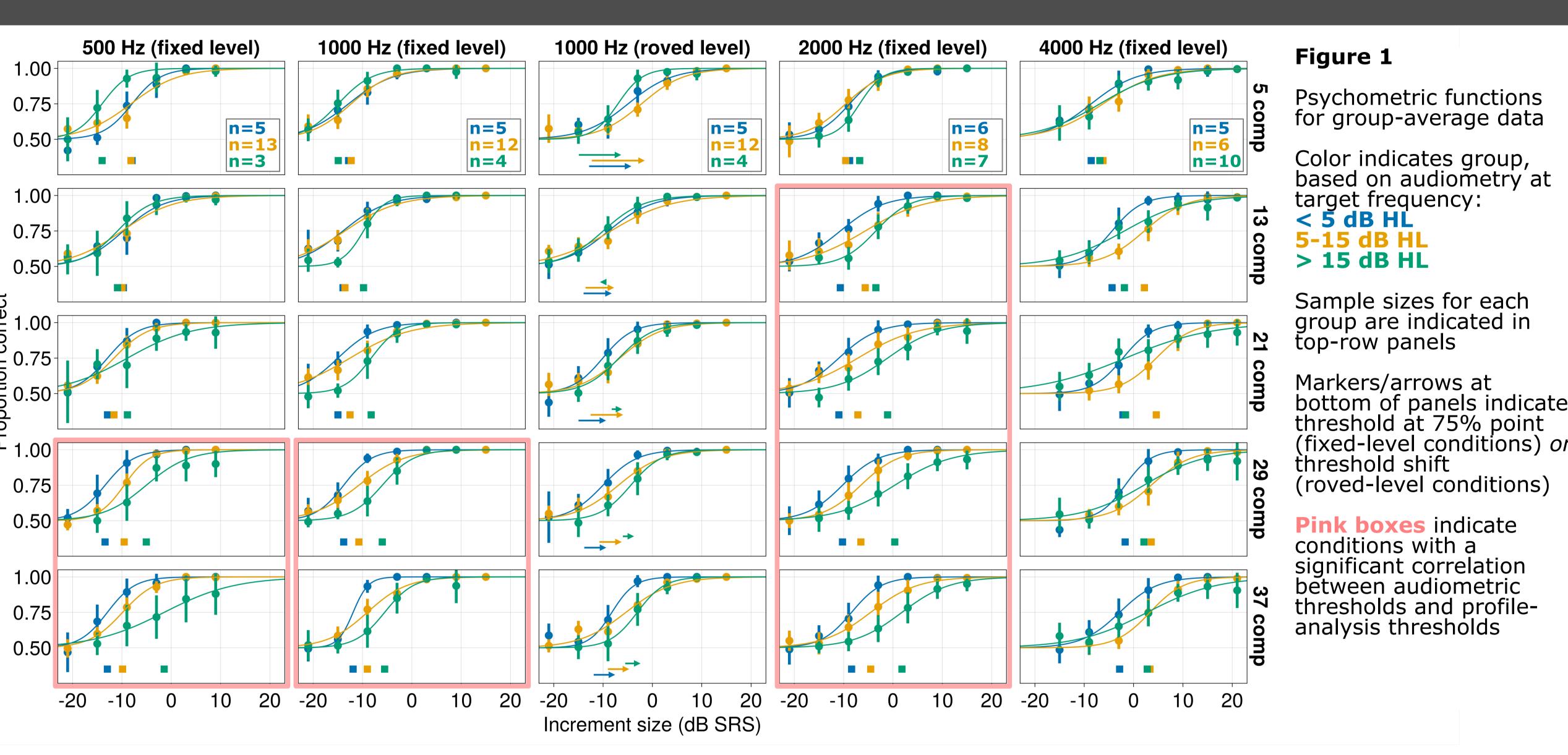
Procedure

Constant-stimulus procedure (60 trials at ~5 increment values per condition)

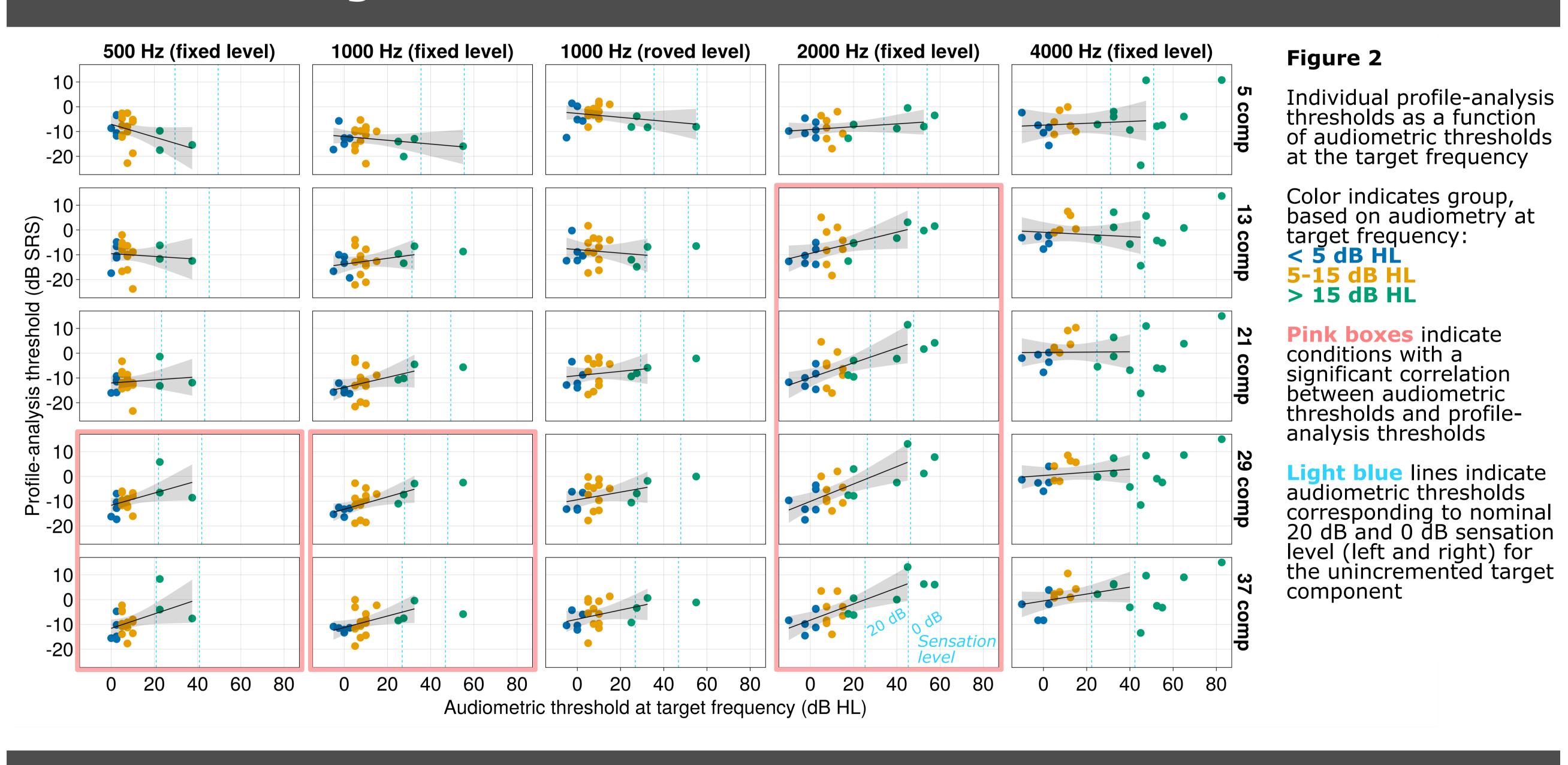
Level increment expressed in units of 20 $\log_{10}(\Delta A/A)$ [dB signal re: standard]

Behavior

Psychometric functions



Hearing loss elevated thresholds in some conditions



Profile analysis worsened at high frequencies

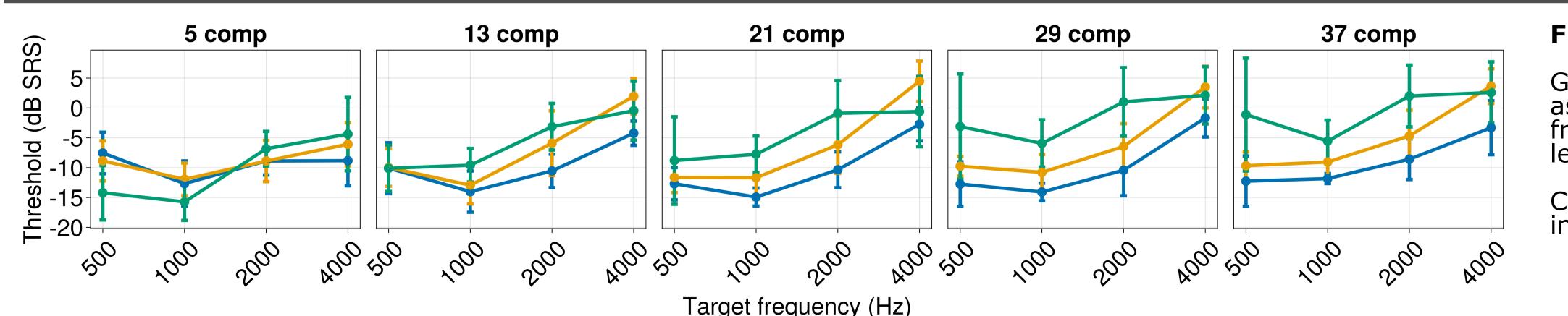


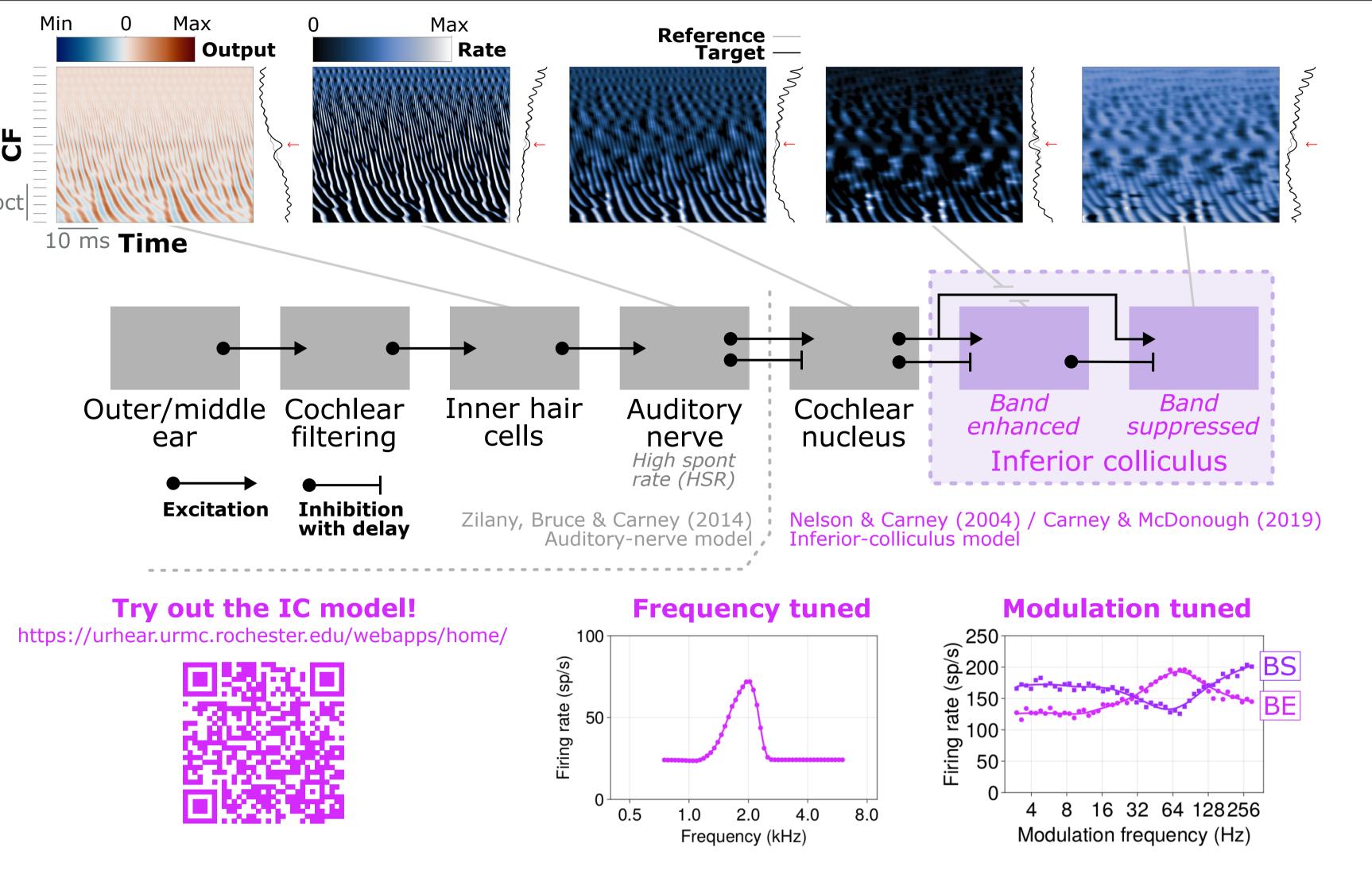
Figure 3

Group-average thresholds as a function of target frequency for the fixed-

Color indicates group as in Figures 1 and 2

Neural simulations

Fluctuation-place code for profile analysis



2000 Hz

Figure 4

Schematic depicting how profile-analysis stimuli elicit extrema in

Middle: Schematic depicting signal flow in combined auditory-nerve and IC model [8, 9, 10]

Bottom: Iso-level tuning curve at 50 dB SPL and function (MTF) for simulated I CF of 2 kHz

Top: Example simulated responses to a 1000-Hz profile-analysis tone with an increment of 0 dB SRS

noise modulation transfer

average discharge rate to

standard deviation, for a

21-component stimulus. **Simulations included**

responses at -5 dB SRS

Bold traces indicate

Black lines at bottom

stimulus components

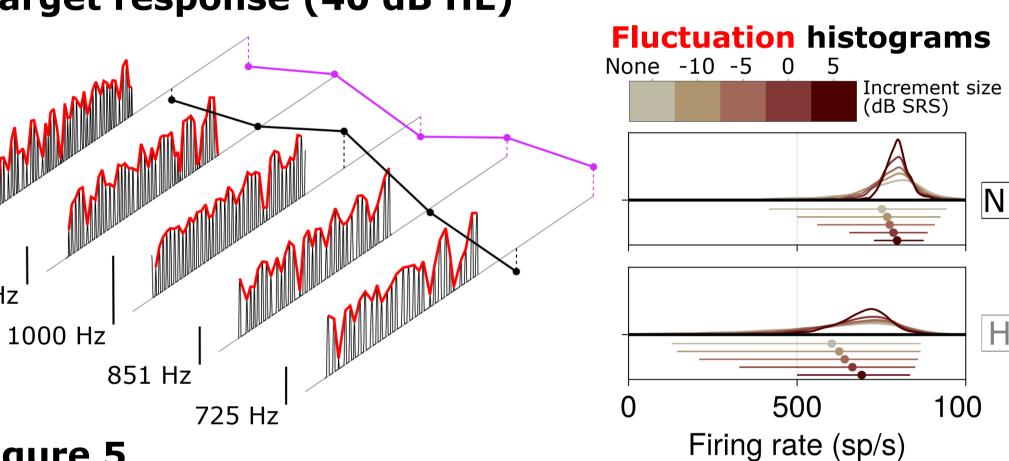
denote positions of

level roving

AN rate profile **Target response (NH)**



Reference response (NH)



20 40 60 80

Level (dB SPL)

Figure 5

Left: Simulated responses for neurons tuned to 5 middle components of 21-component stimulus with 0 dB SRS increment. Average rates were de-meaned and visually exaggerated to emphasize the relative pattern of rates across channels. **Right:** Top to bottom, output-level function for IHC model, rate-level function for AN model, histograms of AN rate envelope at various increment sizes

Conclusions

Frequency range

Profile analysis worsened significantly at high frequencies (Figure 3)

Level roving

Roving elevated thresholds most strongly for 5-component stimuli (Figure 1)

Hearing loss

Hearing loss elevated profile-analysis thresholds, possible interaction with spectral density of stimuli (Figure 2)

Computational modeling

Fluctuation-place code at level of i s may explain frequency and hearing-loss effects (Figures 5, 6, 7)

Acknowledgments

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References

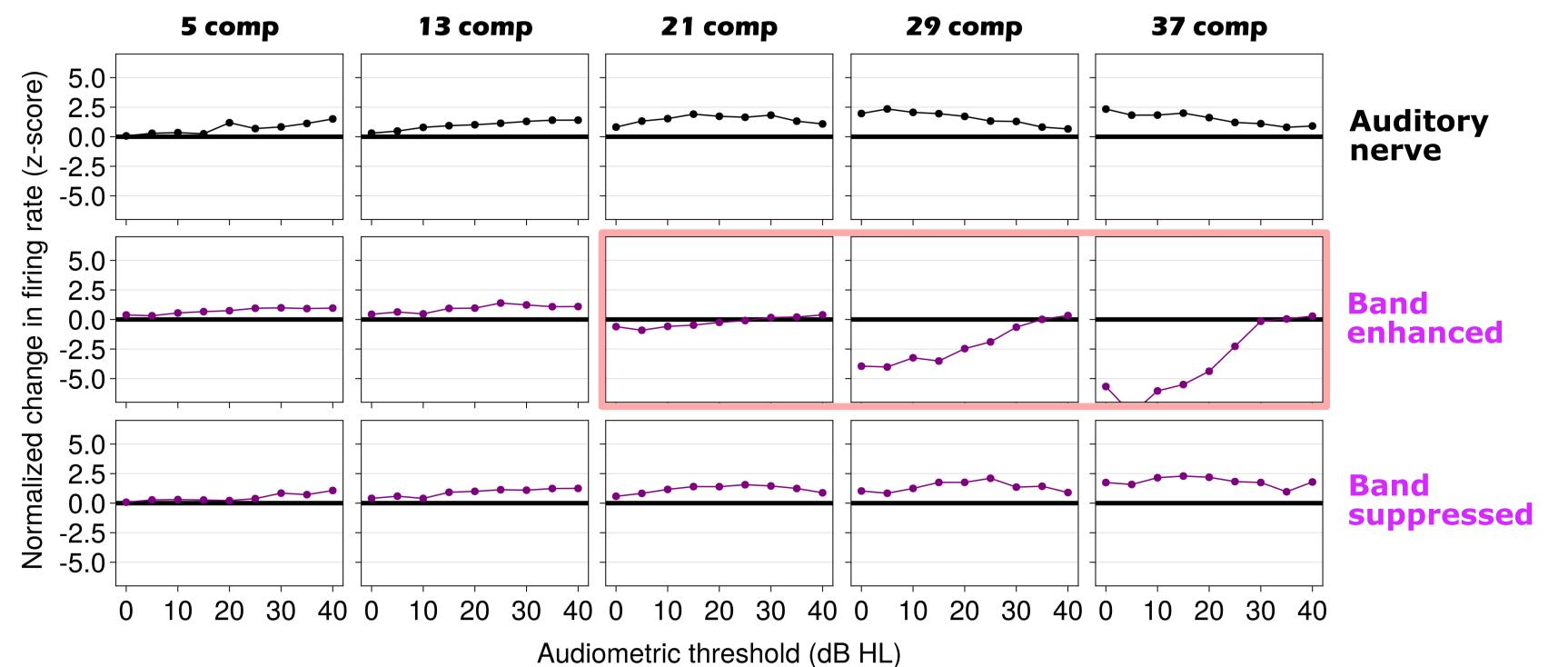
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Band-enhanced IC neurons sensitive to hearing loss

IC rates robust to rove but sensitive to frequency range

-20 -15 -10 -5 0



Characteristic frequency (oct. re: target frequency)

Figure 7

Figure 6

Simulated differences in average discharge rate to target and reference at an increment of 5 dB SRS, normalized by the standard deviation, for model neurons with CFs matching the target frequency of 2 kHz. **Simulations included** level roving.

Pink boxes indicate conditions where ba enhanced responses flipped or vanished as hearing loss increased (see Figure 5 for explanation)