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Measuring Harmonic Benefit in Musicians and Non-Musicians in Several Tasks

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Introduction

- Detection of harmonic complex tones in noise is better than detection of inharmonic complex tones in noise [1, 2]

- F0 discrimination of harmonic complex tones in noise is better than F0 discrimination of inharmonic complex tones in noise [2, 3]

- We refer to these effects as **harmonic benefit**

- Musicians have better pitch perception than musicians [2, 4], but no greater harmonic benefit for F0 discrimination [2]

- Does this hold true for other tasks?

Overview

Methods

- Measured psychophysical performance for harmonic stimuli and inharmonic stimuli in several tasks: detection in noise, F0 discrimination, FM detection, and AM detection

- Performance was measured as a function of SNR in threshold-equalizing noise (TEN; 5)

- Included two subject groups: musicians (N = 12; active musician + more than 10 yeras of training) and non-musicians (N = 19; haven't played in the past 7 years + less than 2 years of training)

Stimuli

Complex tones

- Complex tones with nominal F0 = 250 Hz

- Bandpass filtered from 2 to 12 F0 with 8th order filter

- Harmonic or inharmonic (components independently frequency roved over +/- 50% F0 range across trials, all components separated by at least 5% F0)

- 1 s in duration

- Presented in TEN at 50 dB SPL in ERB at 1 kHz

- Stimuli presented in two-interval two-alternative forced choice

F0 discrimination

- "Pick the higher tone"

FM detection

- "Pick the modulated tone"

- 2 Hz sinusoidal F0 modulation

AM detection

- "Pick the modulated tone"

- 2 Hz sinusoidal amplitude modulation

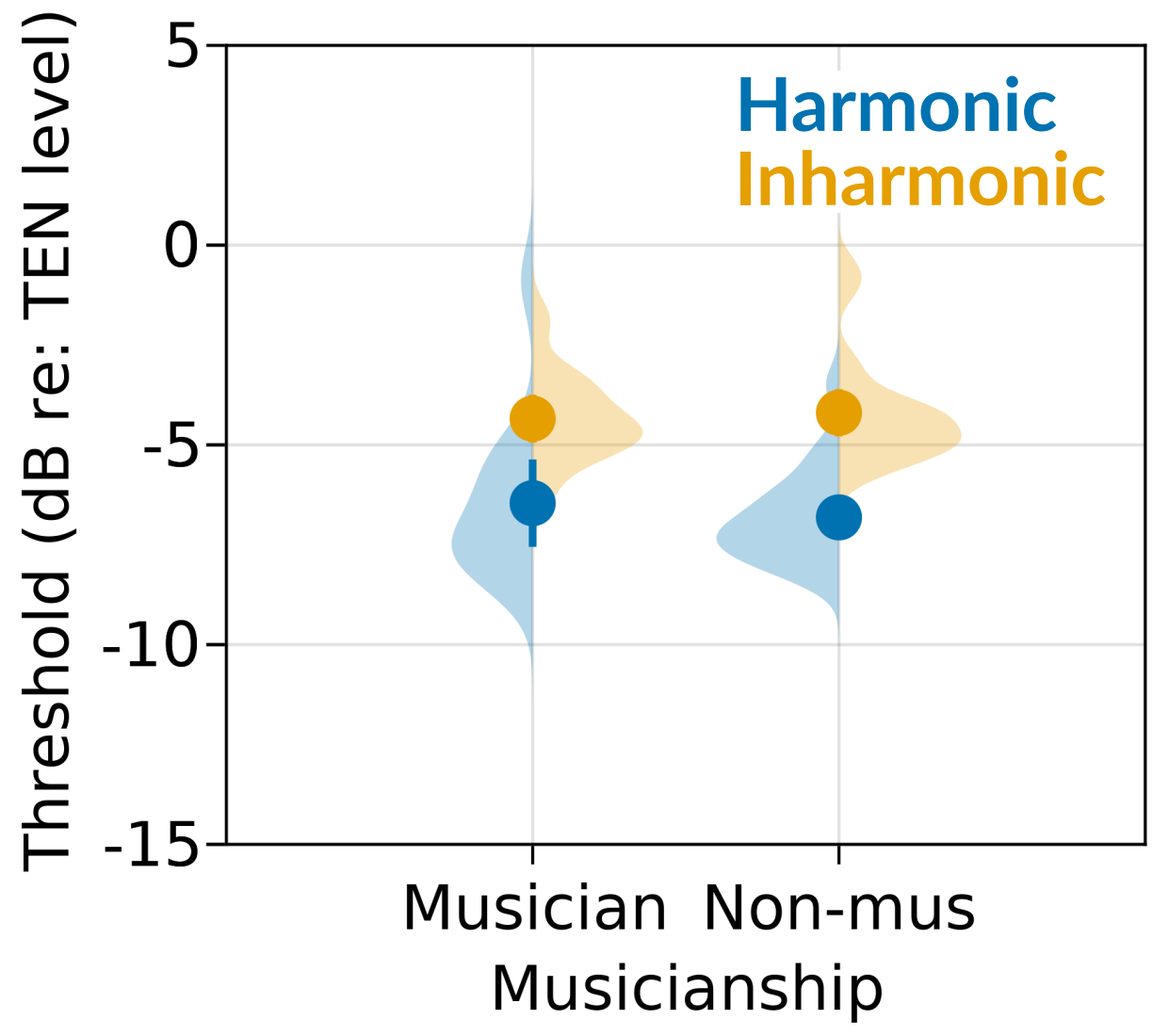


Fig 1. Detection thresholds for the harmonic and inharmonic complex tones in TEN. Harmonic vs inharmonic is indicated by color.

Results

F0 discrimination

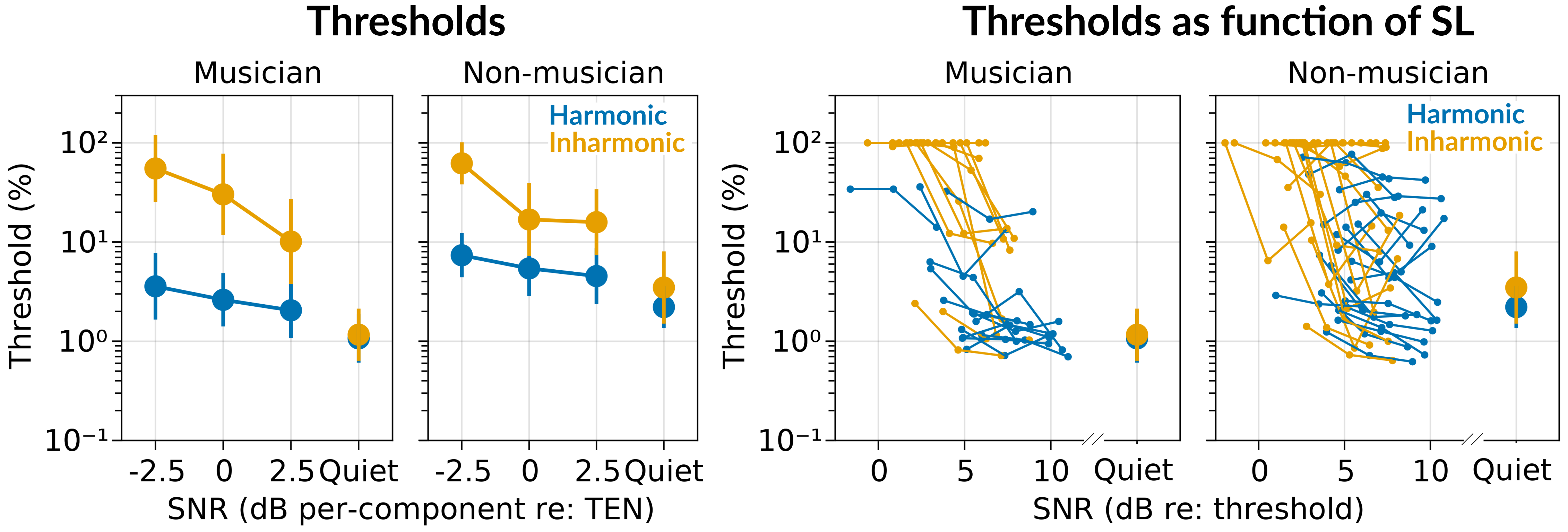
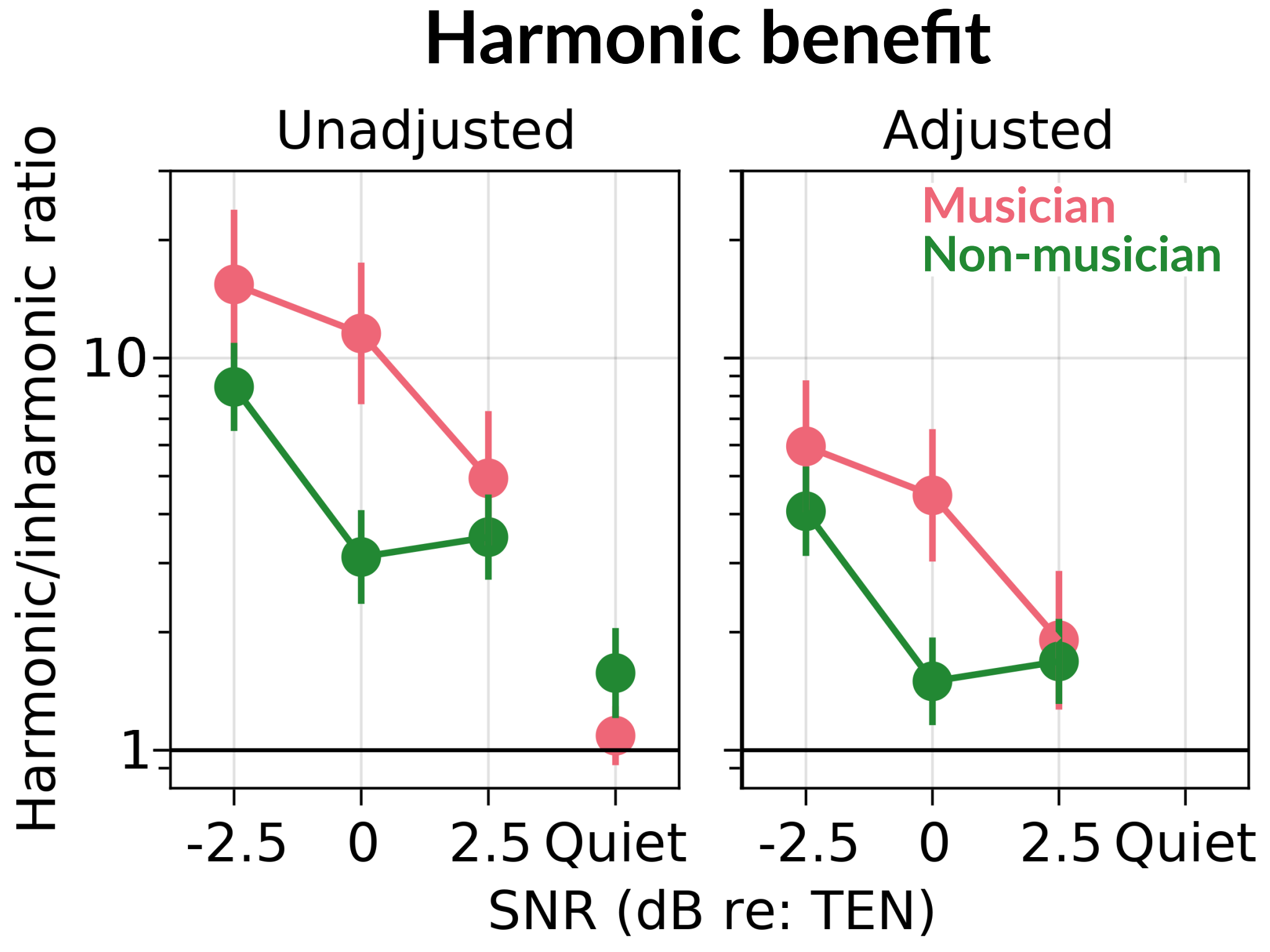


Fig 2.

Left. F0 difference limens for harmonic and inharmonic complex tones in TEN. Harmonic vs inharmonic is indicated via color.

Middle. F0 difference limens as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data.

Right. Ratios of F0 difference limens for harmonic and inharmonic tones. Values above 1 reflect harmonic benefit. Musicians vs non-musicians are indicated via color. Unadjusted numbers reflect data from left, adjusted numbers reflect data after regressing out contribution of SL.



FM detection

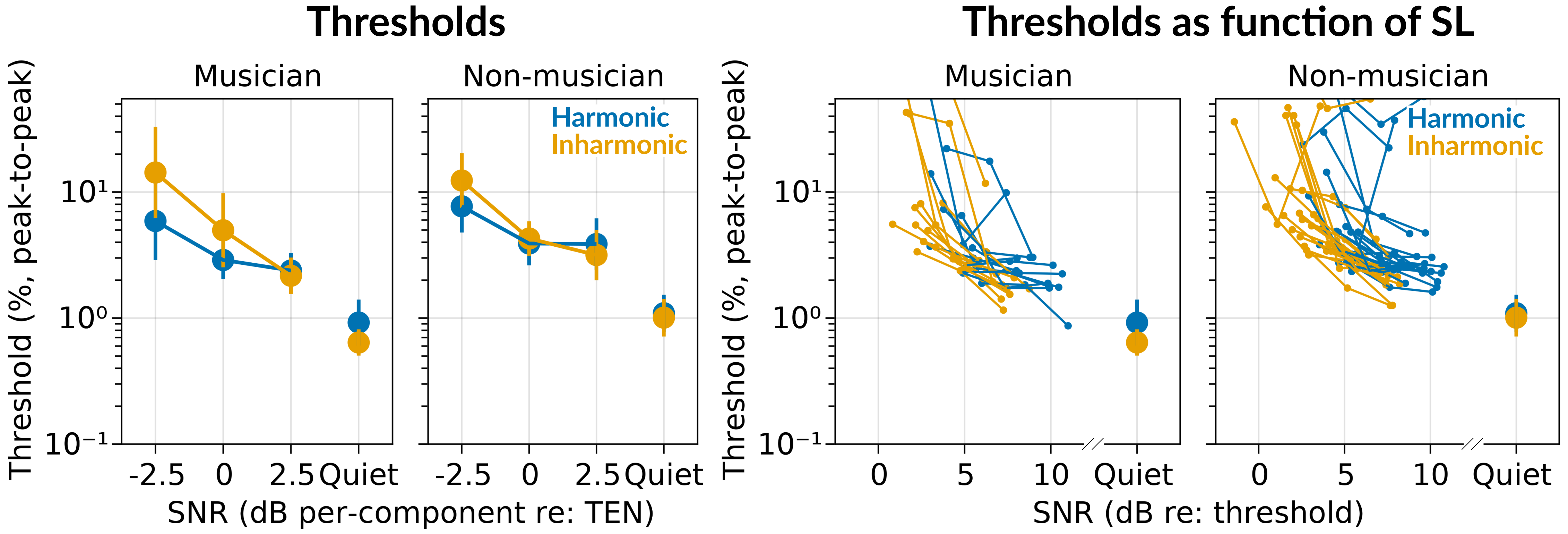
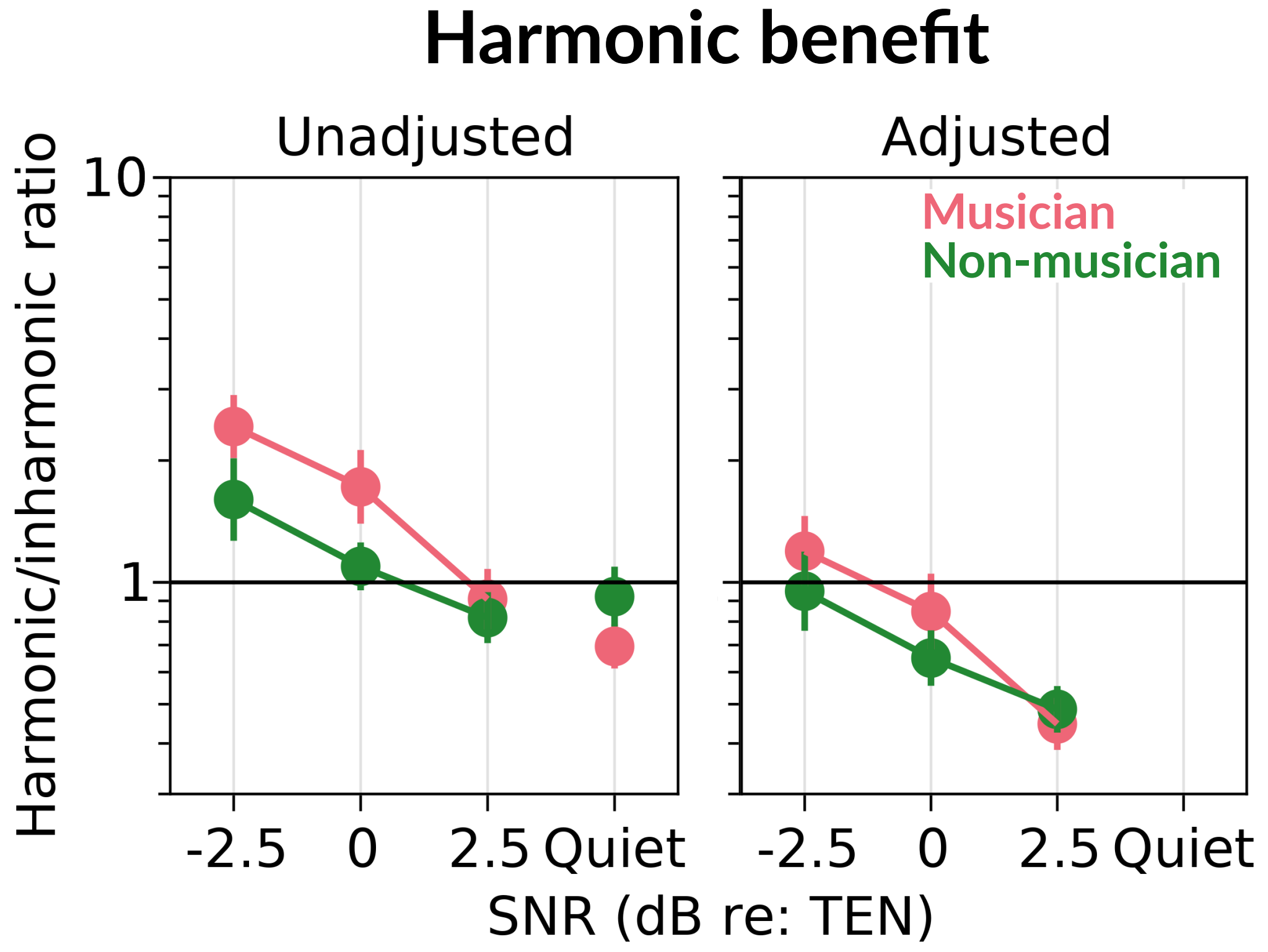


Fig 3.

Left. FM detection thresholds for harmonic and inharmonic complex tones in TEN. Harmonic vs inharmonic is indicated via color.

Middle. FM detection thresholds as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data.

Right. Ratios of FM detection thresholds for harmonic and inharmonic tones. Values above 1 reflect harmonic benefit. Musicians vs non-musicians are indicated via color. Unadjusted numbers reflect data from left, adjusted numbers reflect data after regressing out contribution of SL.



AM detection

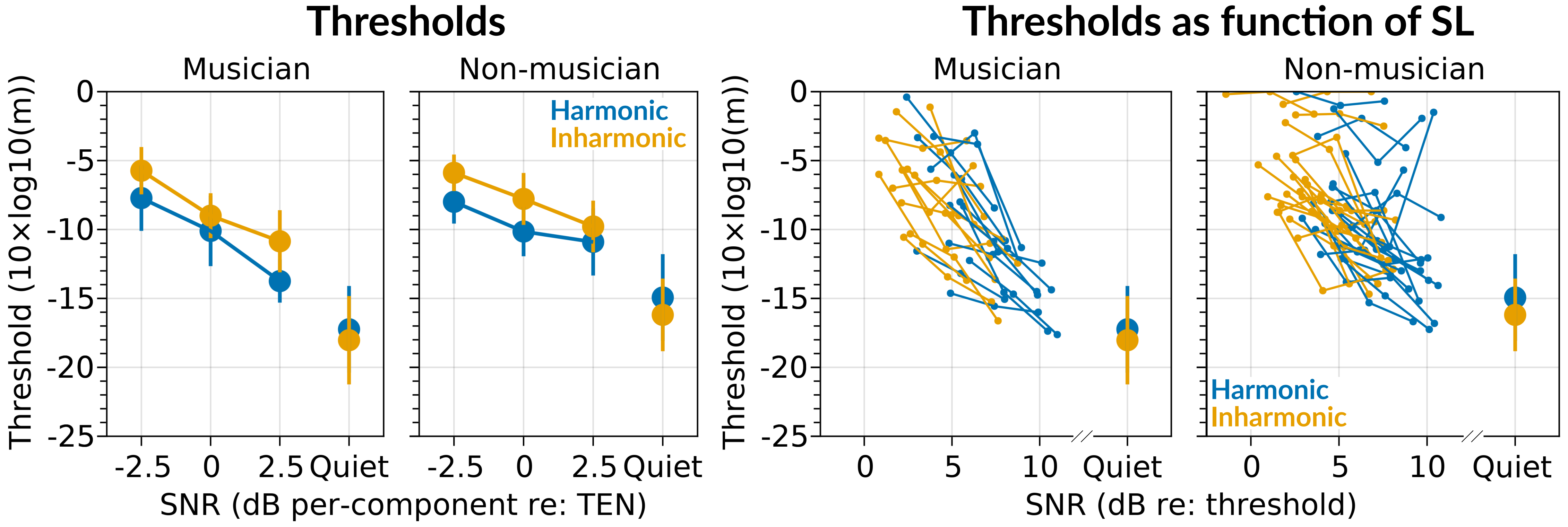
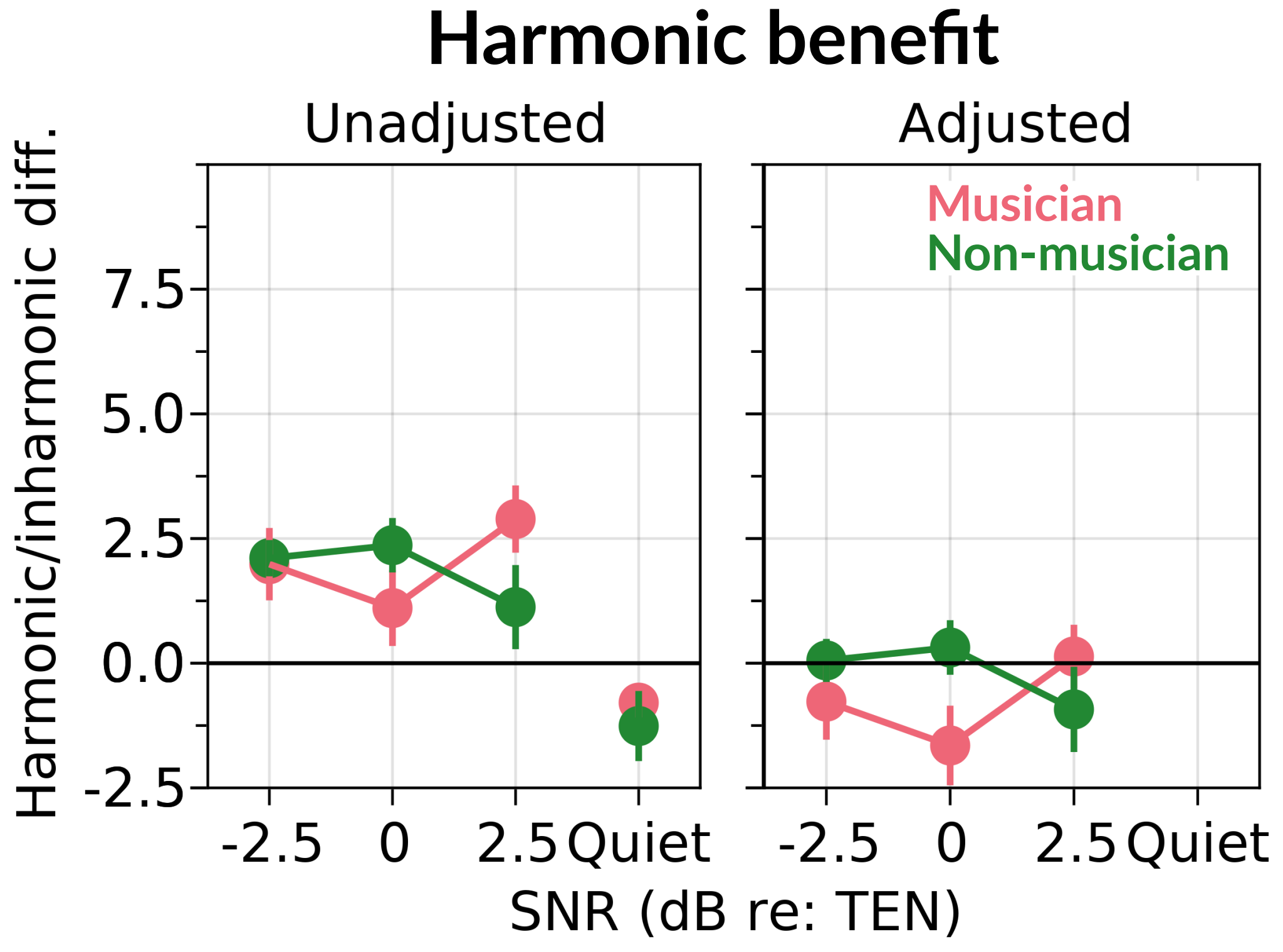


Fig 4.

Left. AM detection thresholds for harmonic and inharmonic complex tones in TEN. Harmonic vs inharmonic is indicated via color.

Middle. AM detection thresholds as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data.

Right. Ratios of AM detection thresholds for harmonic and inharmonic tones. Values above 1 reflect harmonic benefit. Musicians vs non-musicians are indicated via color. Unadjusted numbers reflect data from left, adjusted numbers reflect data after regressing out contribution of SL.



Conclusions

- Substantial harmonic benefit for F0 discrimination in noise, but not in quiet (Fig 2, right)

- Small harmonic benefit for FM and AM detection in noise (Fig 3, right)

- Musicians showed greater harmonic benefit than non-musicians for F0 discrimination and FM detection (Fig 2, right)

- Interaction between musicianship and harmonic benefit differs from results in [1]

- Differences in SL mostly account for differences in harmonic benefit for AM detection (Fig 4, right)

- Harmonic benefit in F0 discrimination is larger than AM/FM detection and only partially explained by differences in SL (Fig 2, right)

Acknowledgments

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Open source code/software:
- AFC [6]
- Julia (Parameters, Chain, Makie, DataFrames, AlgebraofGraphics, DrWatson)
- Inkscape

References

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Supporting materials

Poster available here:

https://guestdaniel.github.io/download/GuestRajappaOxenham2022ARO.pdf