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 detection in noise, F0 discrimination, FM detection, and AM detection using harmonic stimuli and inharmonic stimuli
- 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 years of training)
  - **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

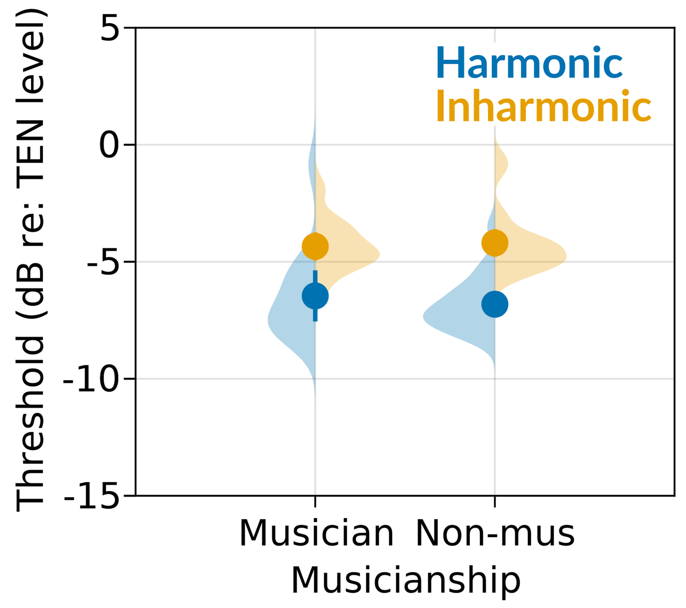

Fig 1. Detection thresholds for the harmonic and inharmonic complex tones in TEN. Harmonic vs inharmonic is indicated by color.

Results

F0 discrimination

Thresholds | **Thresholds as function of SL**

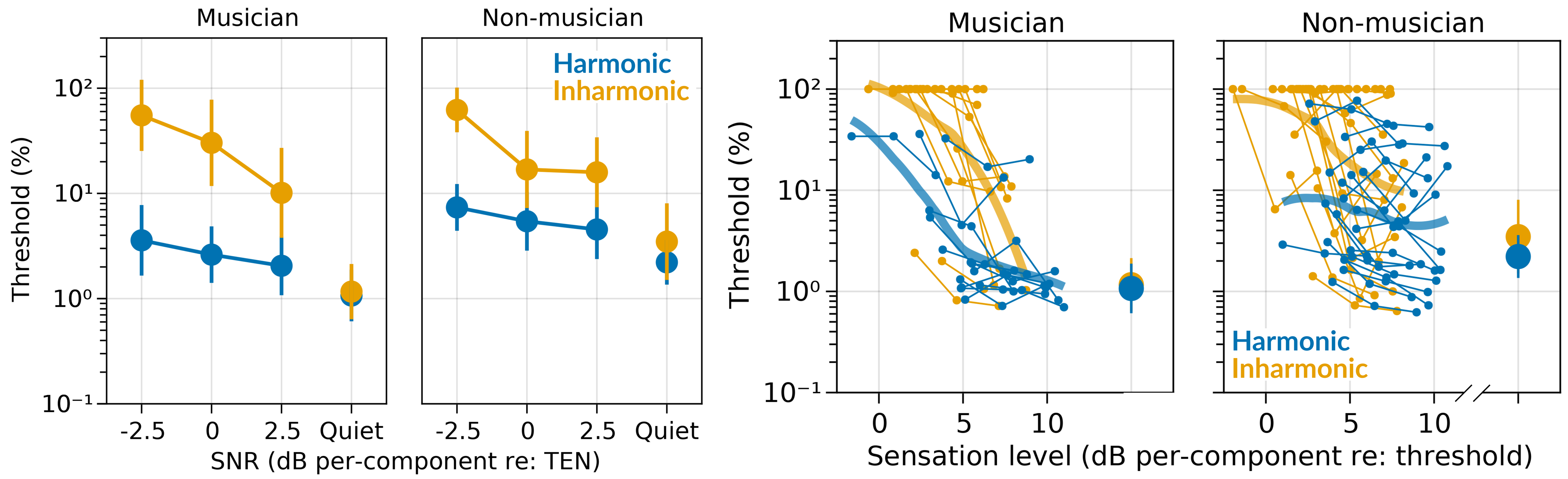

Fig 2.

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

Right. F0 difference limens as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data. Larger points show mean data in quiet. Thicker curves show loess fits to data.

FM detection

Thresholds | **Thresholds as function of SL**

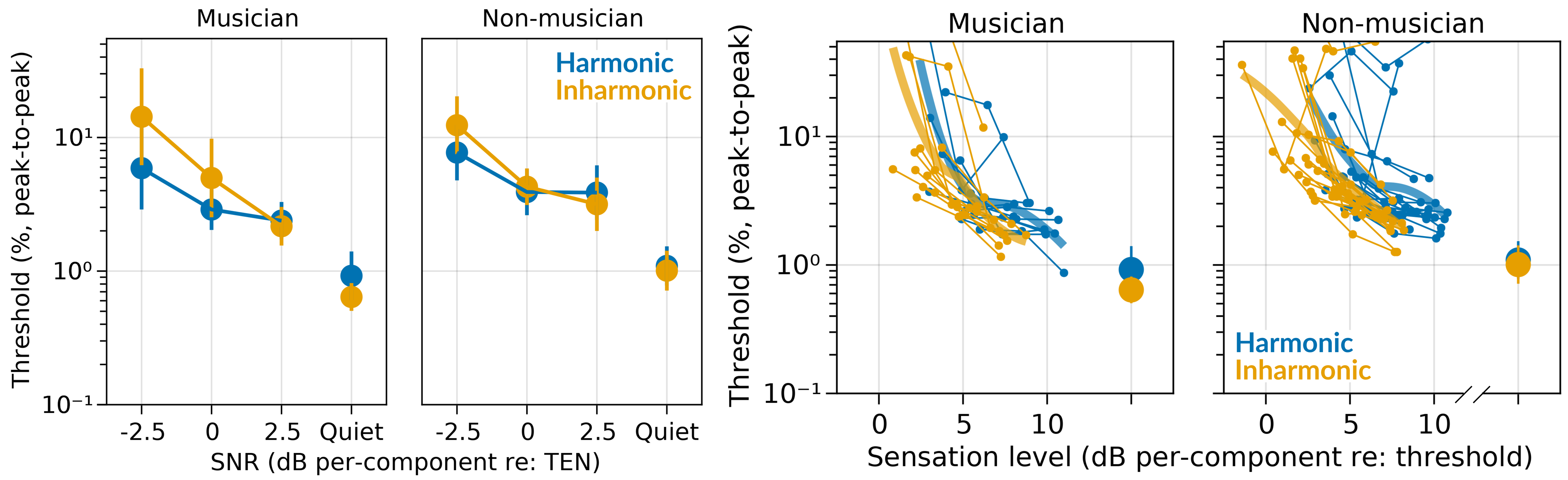

Fig 3.

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

Right. FM detection thresholds as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data. Larger points show mean data in quiet. Thicker curves show loess fits to data.

AM detection

Thresholds | **Thresholds as function of SL**

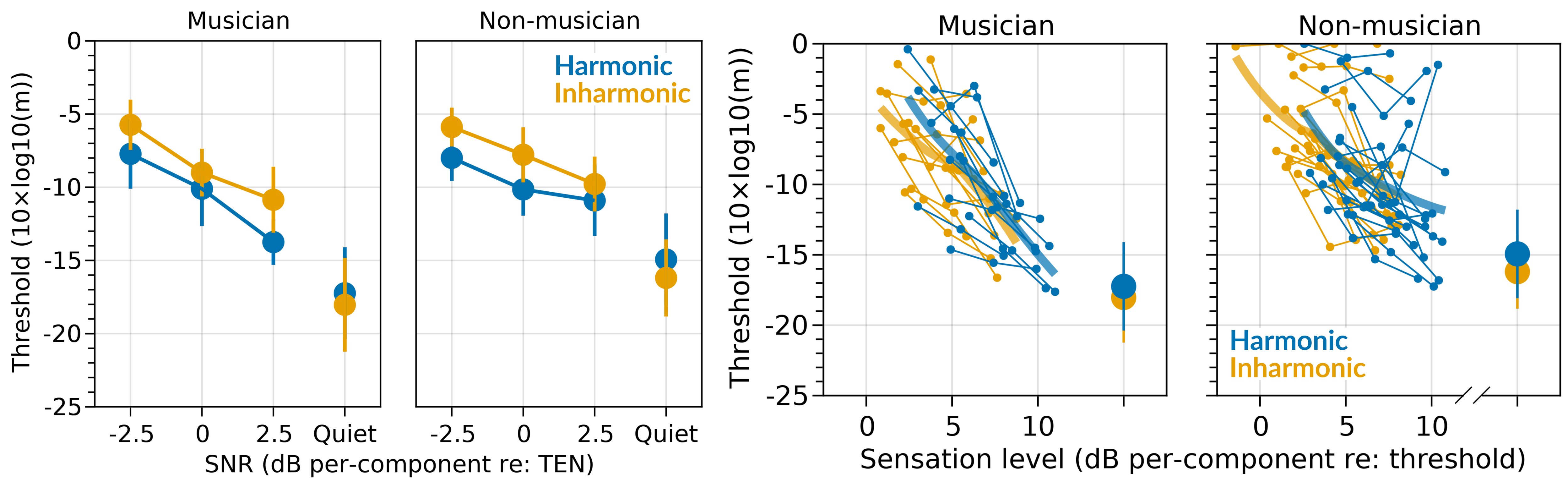

Fig 4.

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

Right. AM detection thresholds as in left, except as a function of SNR in dB: re threshold. Smaller lines and points show individual data. Larger points show mean data in quiet. Thicker curves show loess fits to data.

Conclusions

- Substantial harmonic benefit for F0 discrimination in noise, but not in quiet (Fig 2). This effect persisted even when accounting for differences in detectability of harmonic and inharmonic tones.
- Small harmonic benefit for FM and AM detection in noise (Fig 3, Fig 4). These effects could be accounted for by differences in detectability of harmonic and inharmonic tones.
- **Musicians** showed somewhat larger harmonic benefit than **non-musicians** for F0 discrimination in noise (Fig 2).
  - **Musicians** and **non-musicians** performed similarly for inharmonic tones in noise
  - **Musicians** outperformed **non-musicians** for harmonic tones at 5 dB SL or higher in noise
  - [2] recently reported no additional harmonic advantage for **musicians**; discrepancy may relate to differences in participant pool or task design
- Large spread in **non-musician** F0 discrimination performance for harmonic and inharmonic tones in noise
- **Musicians** outperformed **non-musicians** in F0 discrimination in quiet

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/GuestRajappaOxenham2022ASADenver.pdf