

Vibrato as Rhythmic Subdivision

Cross-Genre Evidence for Vibrato–Tempo Coupling in 100 Commercial Recordings

Michael Van Bebber, D.M.A. (Eastman School of Music) · Independent Researcher, Seattle, WA, USA

ICCCM 2026 · 4th International Conference on Computational and Cognitive Musicology · Würzburg, Germany · Poster Session D · Submission #7

1 Background

Vibrato rate is conventionally treated as a stable trait of the performer, typically 5–8 Hz and independent of musical context (Prame 1994; Sundberg 1995). Desain et al. (2000) asked directly whether rate adapts to tempo: across five players at 54–69 BPM it held for two, and they called the picture unclear. Whole-cycle quantization was raised as a mechanism but not tested. Their tempo range sits entirely inside one zone of this model.

In 2008, after years of hearing vibrato lock to the beat while transcribing at slowed playback, I proposed a mechanism: a performer’s vibrato tracks a subdivision of the beat rather than a frequency in Hz. Rate must then climb as tempo rises — until the subdivision becomes too fast to sustain and the performer steps to a coarser one, dropping rate back down. Rate stability is therefore the **by-product** of stepping between rhythmic subdivisions, and the steps should fall at predictable tempos.

2 Hypothesis

Vibrato is executed as a metric subdivision of the beat. As tempo rises, performers step down through coarser subdivisions, holding absolute rate inside a physiological window near 5–7 Hz.

Subdivision	Notation	Cycles / beat	Predicted (BPM)
Triplet 16ths		× 6	50–75
16ths		× 4	75–100
Triplet 8ths		× 3	100–150
8ths		× 2	150–200
Triplet qtrs		× 1.5	200–300
Quarters		× 1	300–400

Alternating boundaries approximate 2:1 ratios, analogous to octave equivalence in pitch.

3 Method

Corpus. 100 commercial recordings yielding 104 coded observations; four recordings use two subdivisions in different sections and are coded twice.

Coding. Tempo and subdivision determined aurally by one expert rater (D.M.A., jazz performance) against a metronome, with playback slowed pitch-preserved in Transcribe! and YouTube so cycles could be counted individually. Implied rate = tempo × multiplier ÷ 60; all 100 rows are arithmetically self-consistent.

Breadth. 15 genres: jazz (42%), rock, soul, country, classical, pop, blues, bluegrass, opera, disco, Latin, funk, metal, Cuban and klezmer. 61 vocal / 43 instrumental observations across 10 instruments, including cello, oboe, harmonica and electric guitar.

Model. Bayesian ordered logistic regression on log tempo (PyMC; 4 chains × 2,000 post-warmup draws). Crossovers derived from posterior cutpoints. All R-hat = 1.00, minimum bulk ESS > 2,900.

4 Limitations and scope

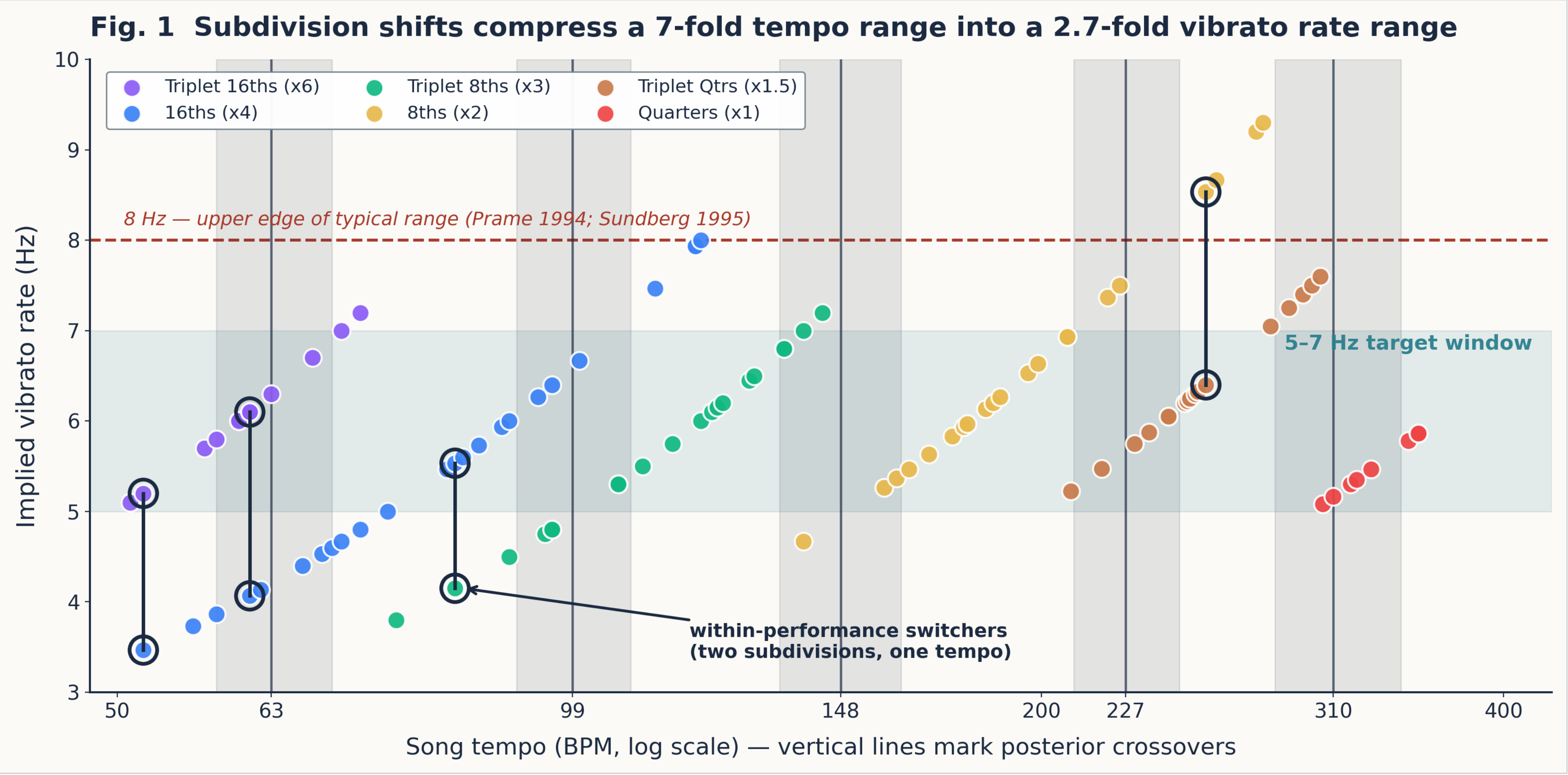
Categories are assigned by ear. Vibrato locking to no subdivision was listened for throughout and proved very rare — consistent with a discrete rather than continuous account. The subdivisions are far enough apart that a wrong call would push implied rate well outside the 5–7 Hz band, so ratios such as 5:2 or 7:4 would be hard to miss. They are effectively absent. Spectral extraction would turn these judgments into measurement; that work is underway.

Single rater. One coder throughout; inter-rater reliability on a 50-recording subset is in progress. The corpus is built so that this can be checked rather than trusted: every recording is commercially released and timestamped in the dataset, so any coding decision here can be verified against the source in about a minute.

Thin categories. Quarters (n = 9) and triplet 16ths (n = 13) fall short of the 15–20 per category wanted for stable cutpoints. The top of the range remains the least firmly estimated.

5 Next steps

Expand to ≈ 220 observations with ≥ 20 per category · spectral verification via Praat · targeted search for further switchers near crossovers.



Each point is one coded observation (n = 104). Color indicates the coded subdivision; shaded vertical bands are 95% credible intervals for the crossover tempos. Circled pairs joined by a line are single performances using two subdivisions in different sections.

KEY FINDING

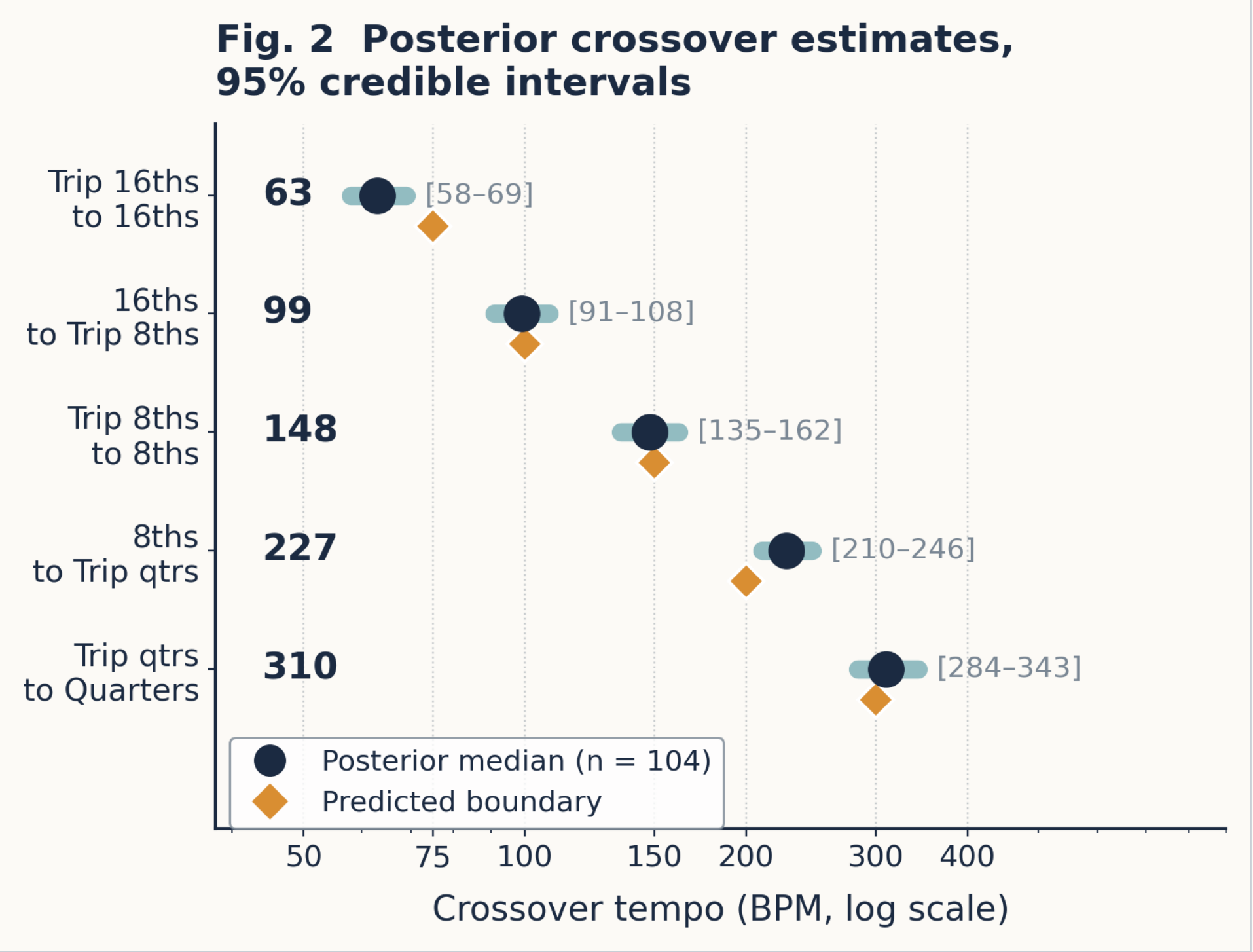
Vibrato rate is not fixed. Its apparent stability emerges from switching rhythmic subdivisions.

Across a sevenfold tempo range and fifteen genres, the subdivision steps down five times.

6 Crossover tempos (BPM)

Crossover	Median	95% CI	Predicted
Trip 16ths → 16ths	63	58–69	75
16ths → Trip 8ths	99	91–108	100
Trip 8ths → 8ths	148	135–162	150
8ths → Trip qtrs	227	210–246	200
Trip qtrs → Quarters	310	284–343	300

All five boundaries were predicted by ear years before any modeling. Three fall inside the posterior interval — 100, 150 and 300. Two do not: 75 moved to 63, and 200 to 227. The 150 boundary is the least firmly pinned, resting on no observations between 144 and 158.



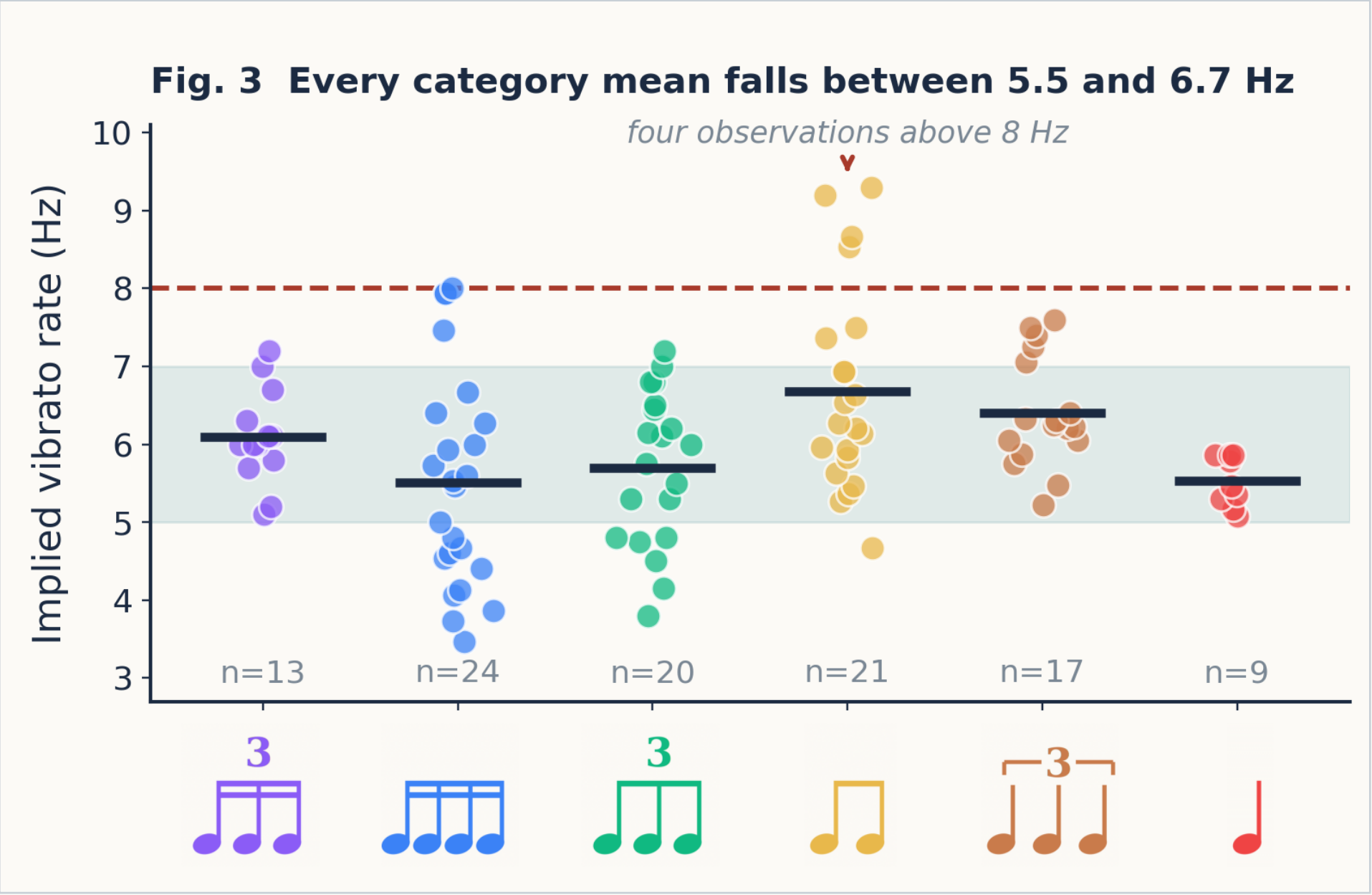
7 Implied-rate audit

Implied rate is arithmetic, providing an external plausibility check on the subdivision coding. Eleven observations came out above 8 Hz — the upper edge of the range usually reported — and were re-coded from the recordings against a metronome. **Nine changed.** One was not a coding error at all: *La Guarachera* carried a tempo error, 128 BPM entered for a 253 BPM performance. A second became a fourth switcher: Coltrane’s *Impressions*, 256 BPM.

The check earns its place by what it caught, not by the threshold. Vibrato above 8 Hz is documented — Desain et al. report rates to 12 Hz — so the four observations still between 8.5 and 9.3 Hz are plausibly just fast, and are reported rather than adjusted. Zone agreement rose from 63% to 69%.

References

Desain, P., Honing, H., Aarts, R. & Timmers, R. (2000). Rhythmic aspects of vibrato. In *Rhythm Perception and Production*, 203–216. Swets & Zeitlinger.
Prame, E. (1994). Measurements of the vibrato rate of ten singers. *JASA*, 96(4), 1979–1984.
Sundberg, J. (1995). Acoustic and psychoacoustic aspects of vocal vibrato. In *Vibrato*. Singular Publishing.



8 Singers and instrumentalists behave alike

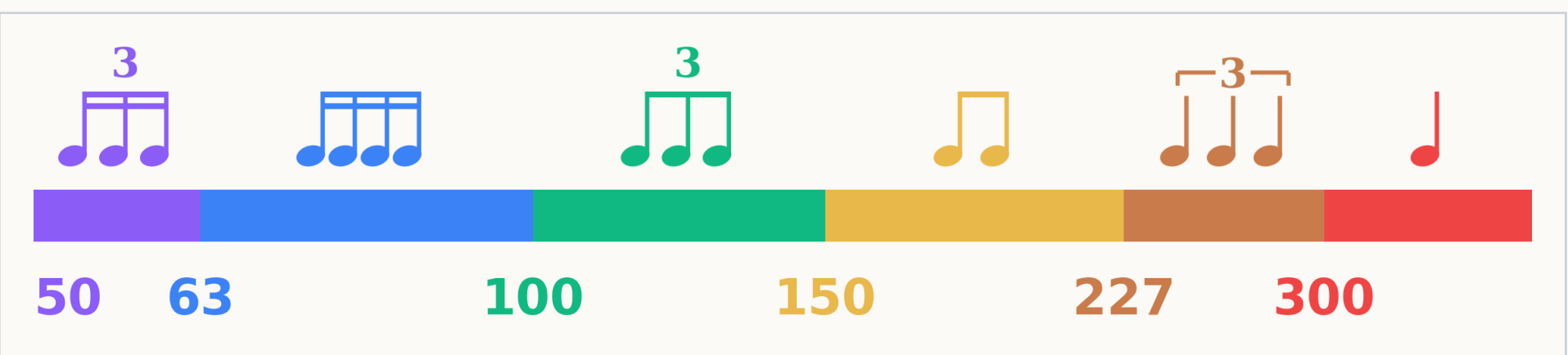
Vibrato is produced by very different machinery — the larynx, breath and embouchure, a finger on a string — so performer types might well cross over at different tempos. Adding performer type to the model tests this. **It finds no evidence of a difference:** $\gamma = -0.47$, 95% CI [–1.33, 0.39], comfortably spanning zero. Vocal and instrumental observations span the full tempo range, so the test had room to find an effect had there been one. Subdivision choice looks like general timing behavior, not something specific to an instrument.

9 Within-performance switching

Four recordings use two subdivisions in different sections at one unchanging tempo: Miles Davis, *My Ship* (52 BPM) and Johnny Hodges, *Isfahan* (61), both alternating triplet 16ths with 16ths; the Bee Gees, *Too Much Heaven* (83), 16ths with triplet 8ths and three voices switching together; and Coltrane, *Impressions* (256), 8ths with triplet quarters.

A continuous-rate account must explain why the rate takes two discrete values rather than drifting between them. Three of the four sit within 16 BPM of an estimated crossover: **switching should cluster at boundaries.** At n = 4 this is a prediction, not a result.

10 Translation to practice



Vibrato Trainer, free on web and iOS, picks the subdivision a player should aim for at a given tempo. Its boundaries use the **posterior** estimates above, not the predicted zones in section 2 — 75 → 63 and 200 → 227.



Free iOS app