

ON THE INFLUENCE OF INSTRUMENT SPECIFICS AND COGNITIVE LOAD ON WALKING BASS IMPROVISATION

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INTRODUCTION

- Not only solos are improvised but also accompaniment (bs, p, dr).
- Walking bass is **the** prevailing standard of jazz accompaniment since the late 1930s / early 1940s.
- Walking bass lines seldom investigated in jazz research (Skinner 2016, Pfleiderer et al. 2016)
- Several walking bass generation algorithms available (Johnson-Laird 1991, Dias & Guedes 2013, Band-In-The-Box).
- Textbooks and teaching materials are relatively scarce compared with other jazz instruments (Carter 1998, Goldsby 2002, Brown 1999, Downes 2004).

WALKING BASS IMPROVISATION

- Walking bass improvisation (WBI) can be viewed as creative problem solving under constraints.
- A bass player is expected to provide a solid harmonic and rhythmic foundation:
 - Spelling out chord changes with smooth and/or interesting melodic lines.
 - Moving in quarter notes plus tonal and rhythmic embellishments.

WALKING BASS IMPROVISATION

- Double bass is a particularly clumsy instrument.
- Large spacing, strong forces, low volume (played without amplification till the 1950s).
- Finding musical meaningful, non-redundant and playable melodic connections between chords is challenging (particularly in high tempo).
- Prevalent keys in jazz (F, Bb, C, Eb) sit not well with double-bass tuning in E1, A1, D1, G1.

AIMS

- Explorative and descriptive study of a large corpus of automatically transcribed walking bass lines (first study in both regards).
- Generating hypotheses about musical constraints, cognitive load and instrument affordances.
- Walking bass lines relatively simple and rule-based compared to other jazz improvisation: Promising testbed to examine improvisation as problem solving.

DATA

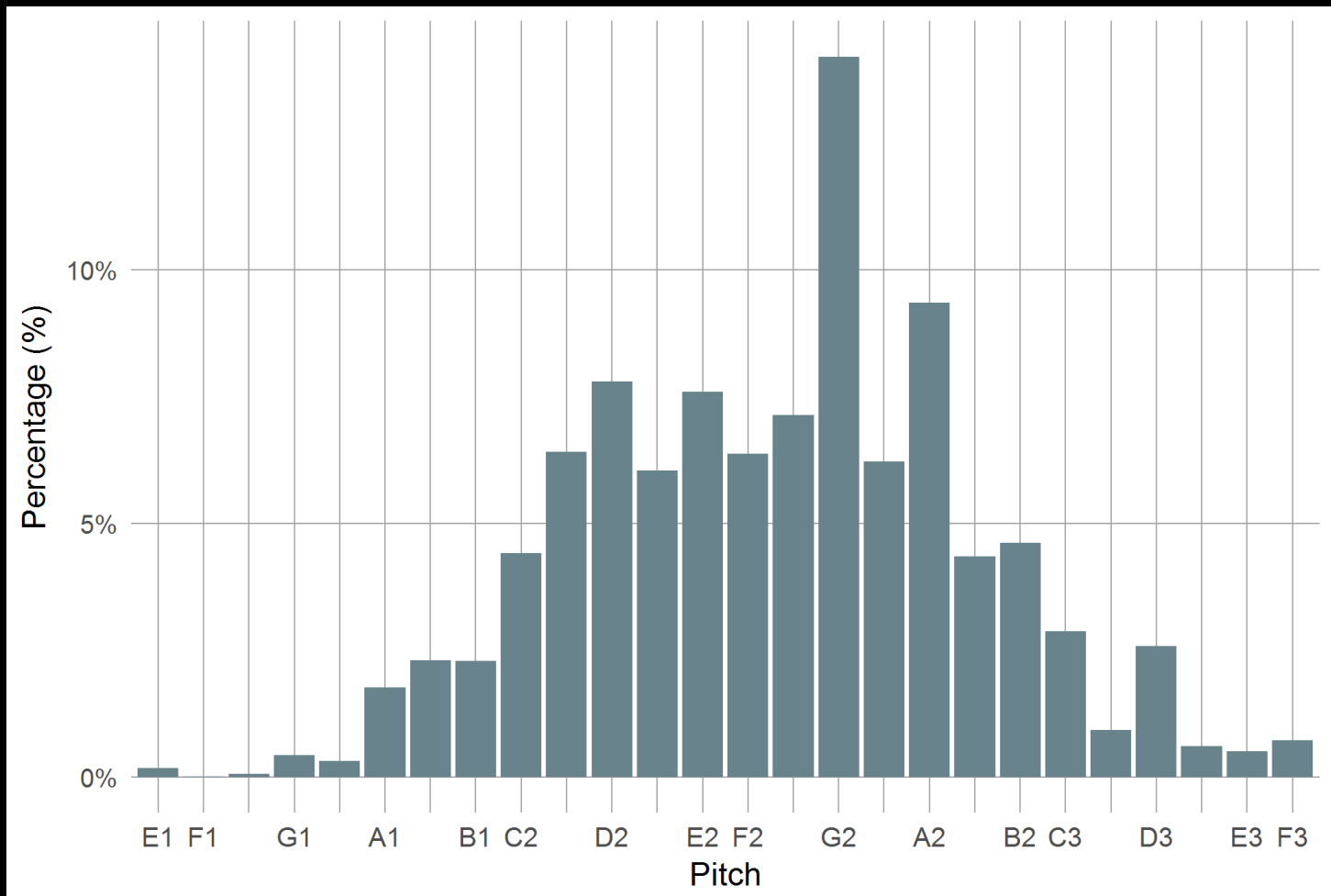
DATA

- 456 solos from the Weimar Jazz Database, beat-annotated.
- Bass notes extracted using deep learning methods (Abeßer, Balke, Frieler, Pfeleiderer, & Müller, M. 2017).
- Additional metadata (e.g. chord symbols, tempo, tonality).
- Selected solos with SWING rhythm feel in 4/4 time.
- Removed “no chord” sections and incomplete bars.
- 332 transcriptions of walking bass lines by 78 different players with 94.149 tones in total.
- Mean accuracy 83% for pitches and 89% for pitch classes.
- #Tones: AM = 283.0, SD = 206, Range = 47-1718(!).
- Pitch range: 28-53 (E1-F3).
- Time span: 1936-2001.

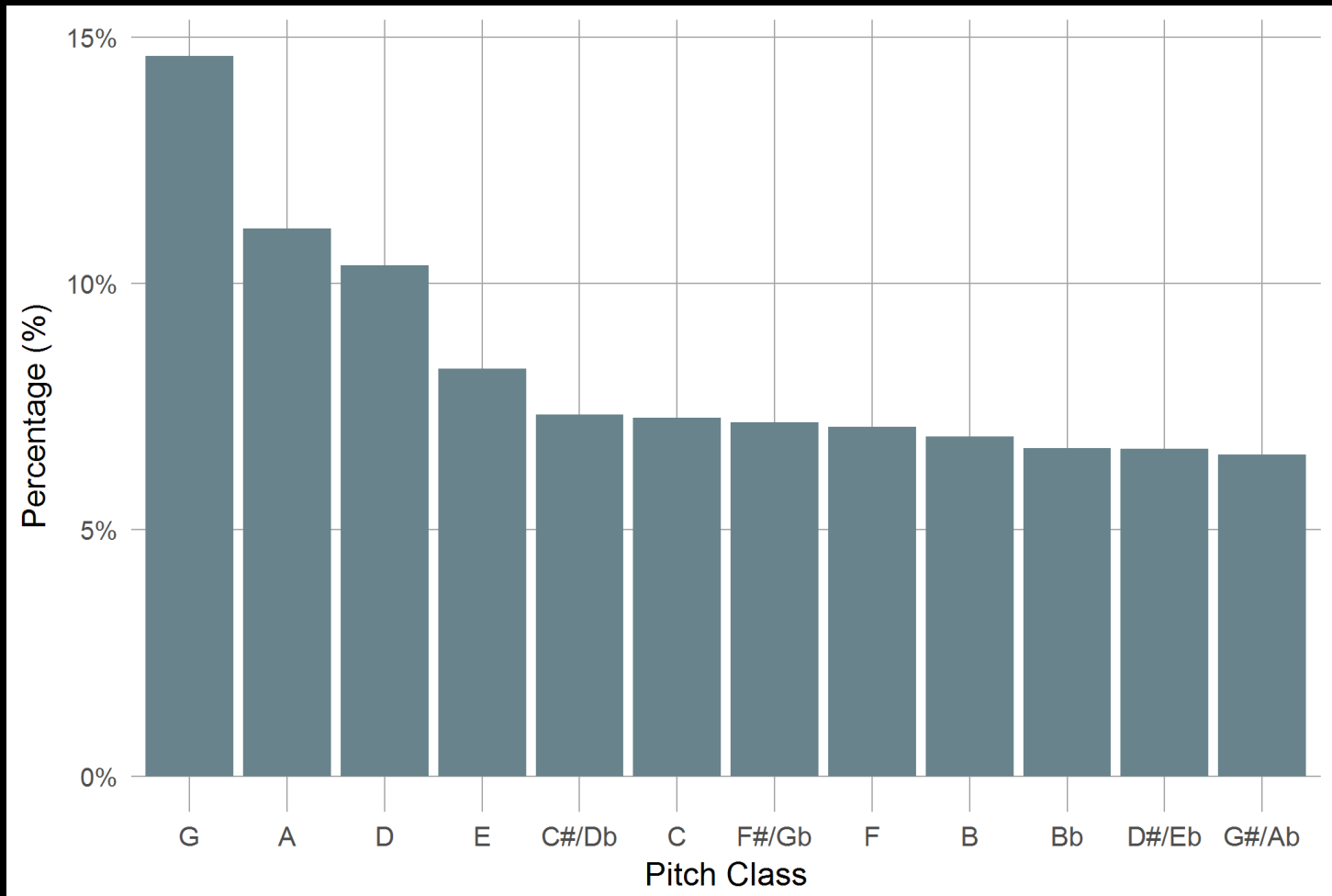
DATA: PLAYERS

Player	Number of solos
Paul Chambers	26
Ray Brown	18
Dave Holland	15
Curly Russell	14
Ron Carter	14
UNKNOWN	13
Percy Heath	11
Doug Watkins	9
Milt Hinton	8
Rodney Richardson	8
OTHER	195

DATA: PITCHES



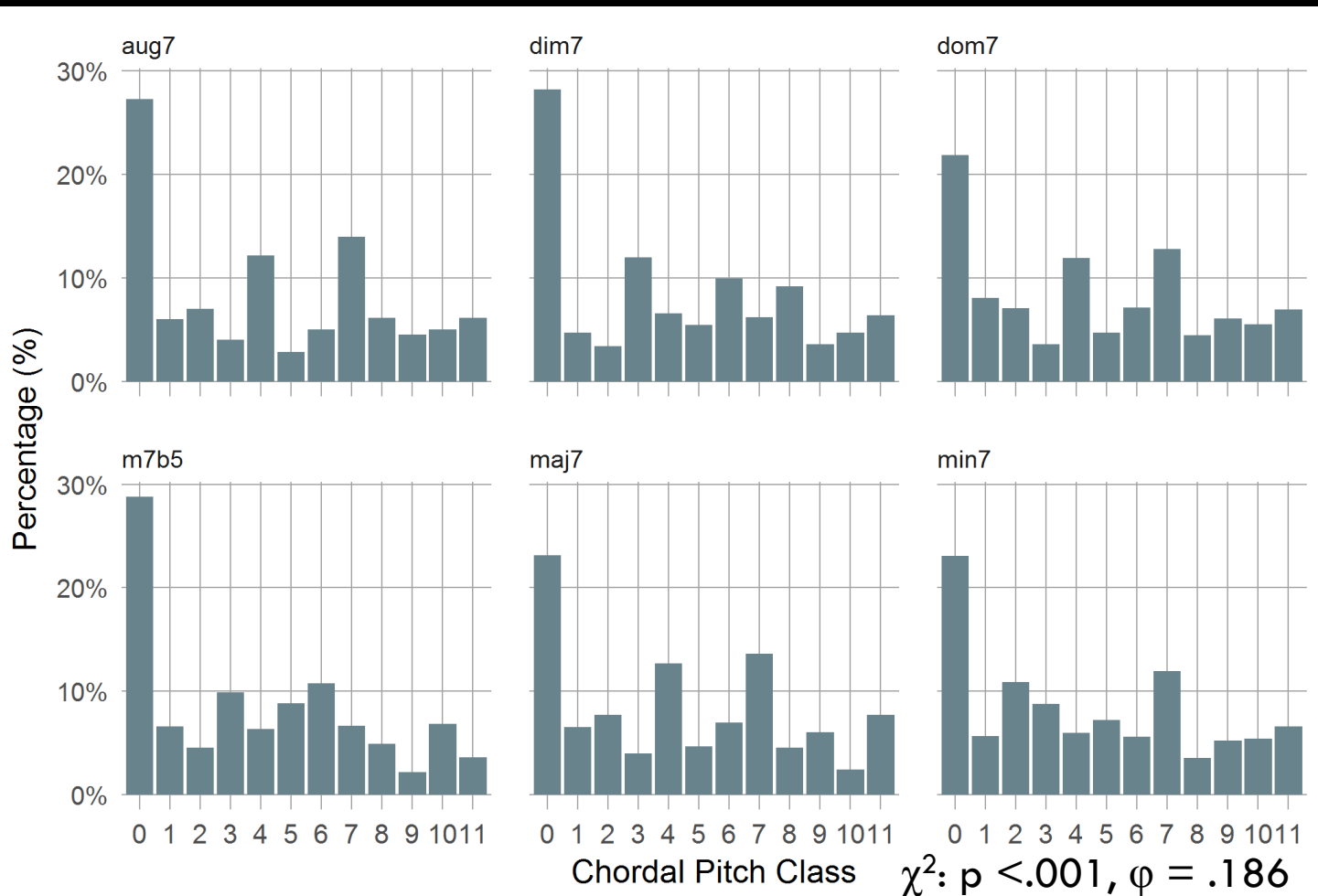
DATA: PITCH CLASSES



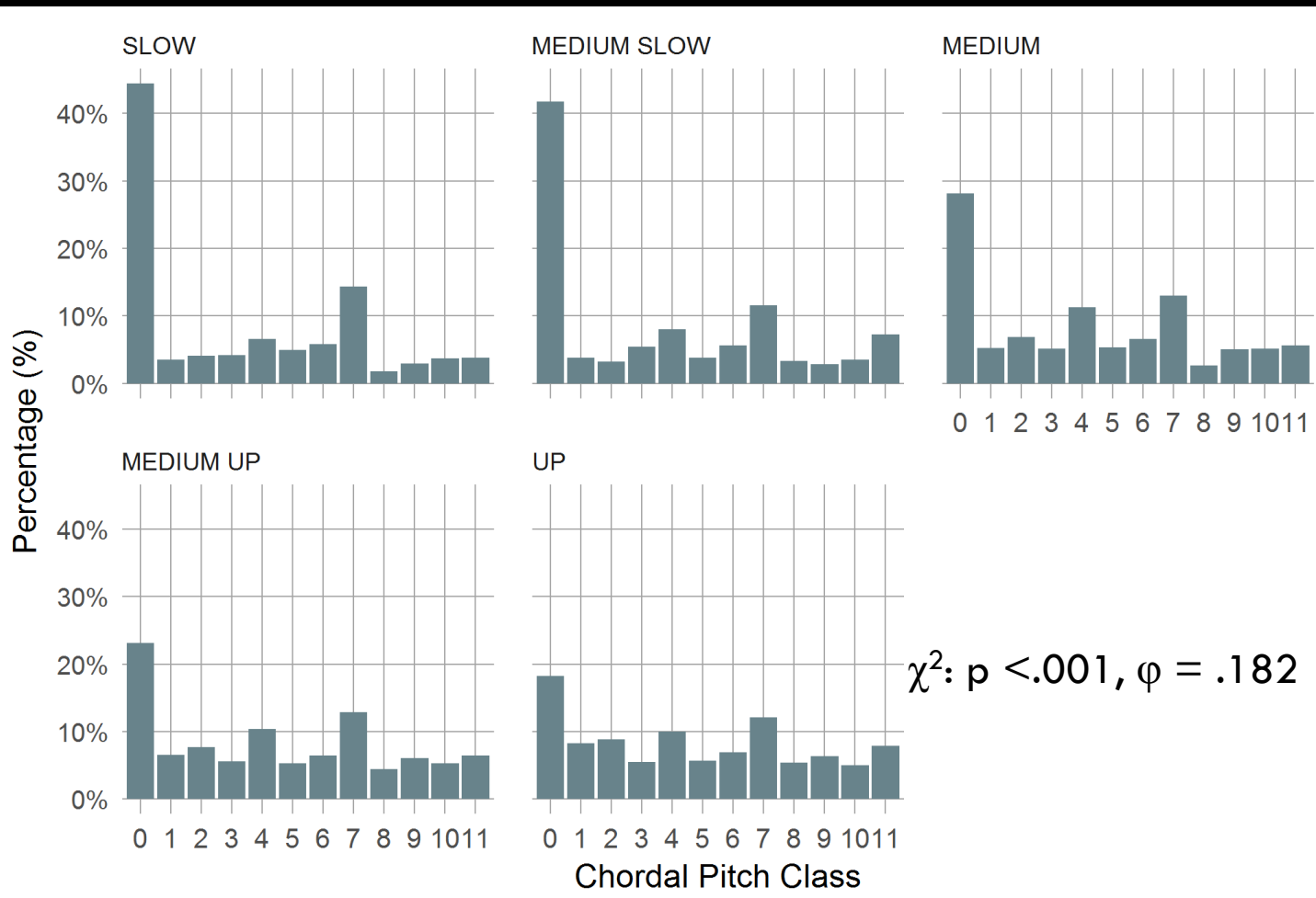
RESULTS: CPC FREQUENCIES

Chordal pitch classes (CPC): Pitch class with the root of the surrounding chord as reference (root = 0, m3 = 3, M3 = 4, P4 = 5, P5 = 7 etc.)

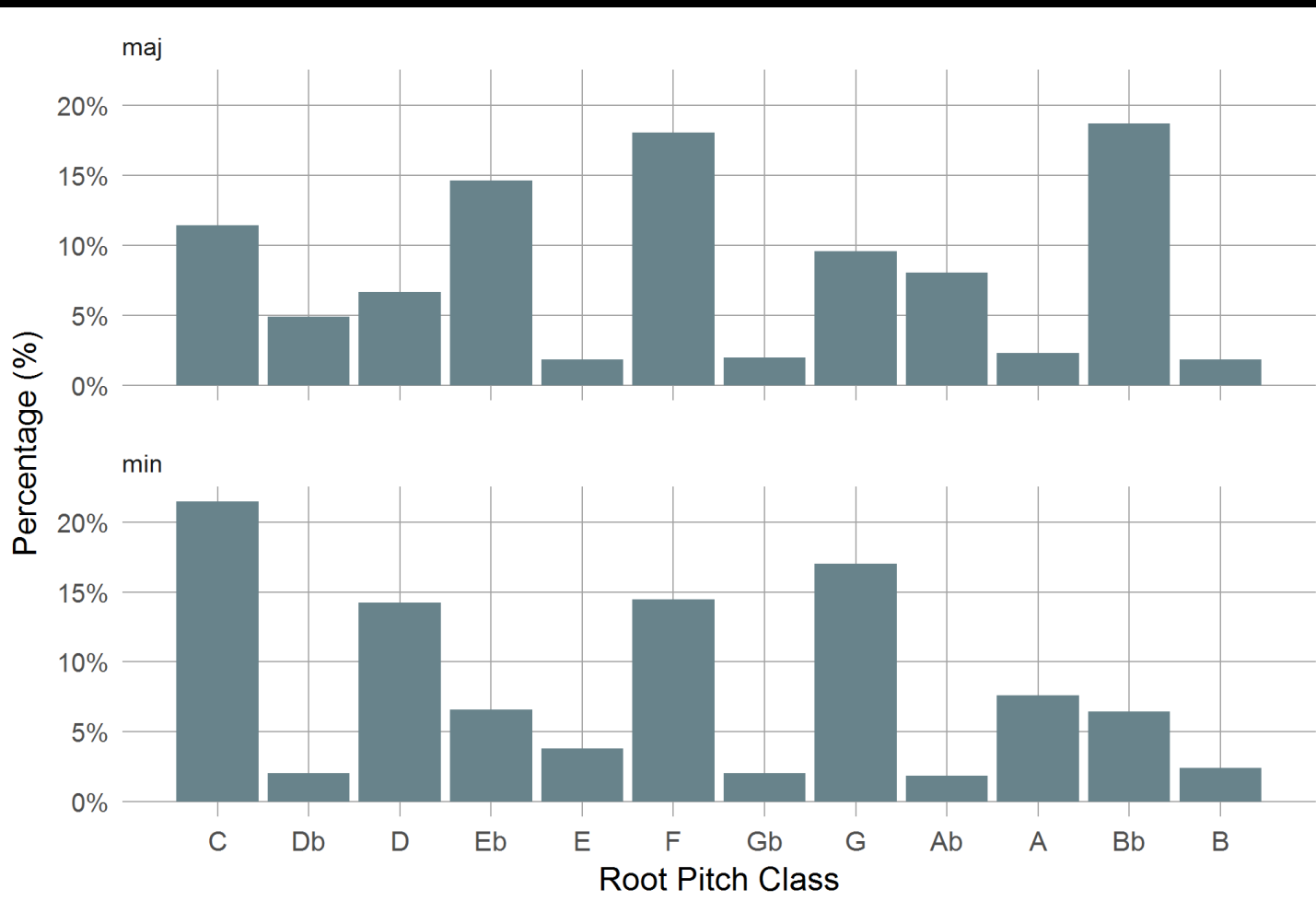
CPC FREQUENCIES / CHORD TYPE



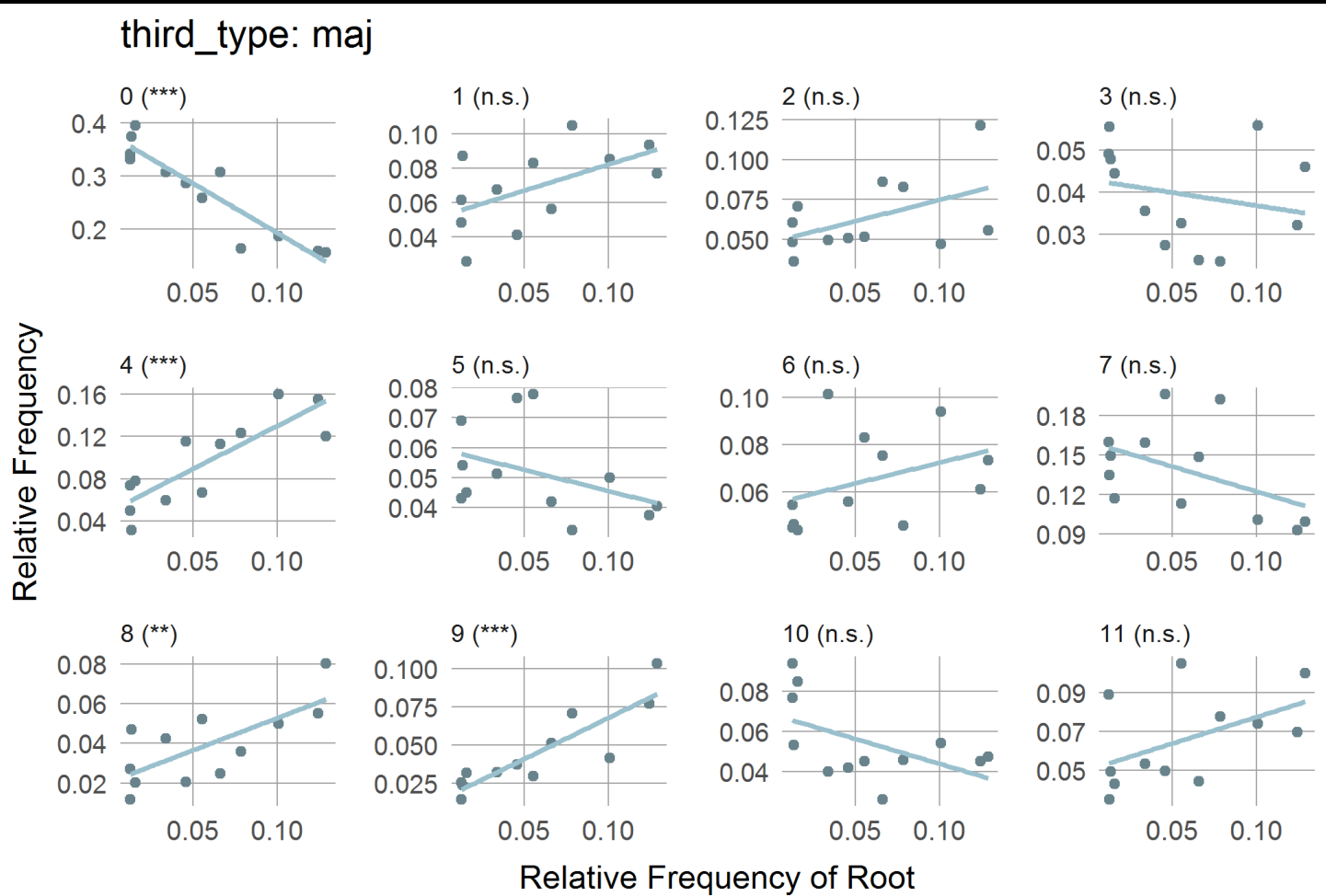
CPC FREQUENCIES / TEMPO CLASS



CHORD ROOT FREQUENCIES



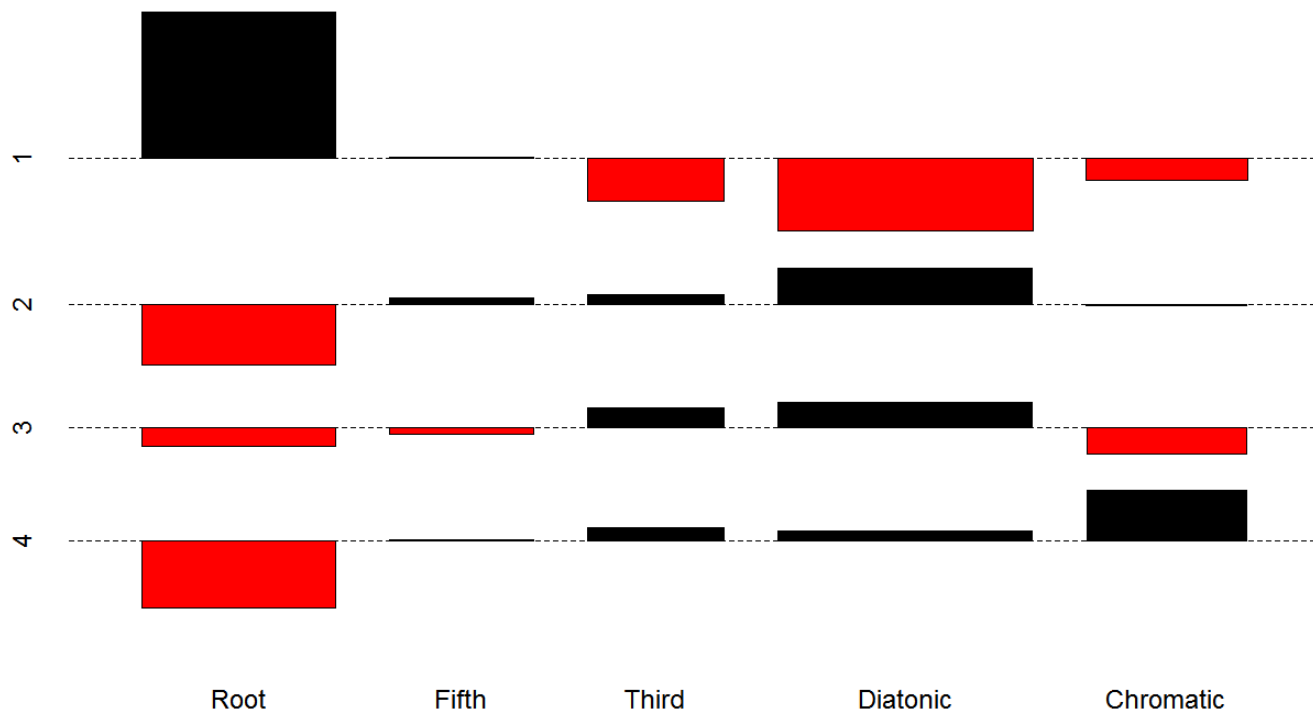
CPC FREQ / ROOT FREQ / MAT



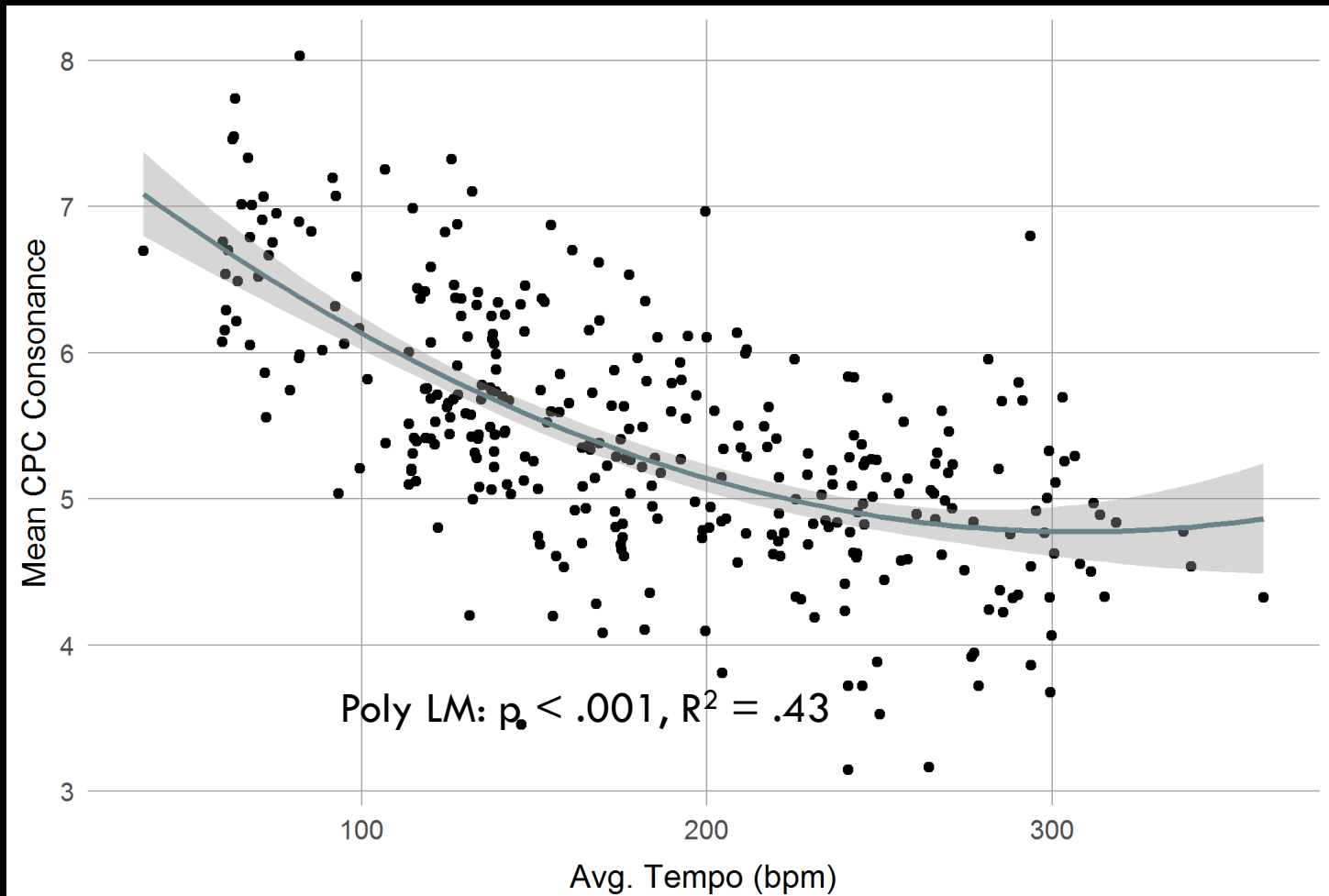
RESULTS: CPC CONSONANCE

- CPC consonance: Weighted sum of basic consonances (root = 5, fifth = 4, third = 3, diatonic = 2, chromatic = 1 with adjustments for diminished and augmented chords).

CPC CONSONANCE X BEAT MATRIX

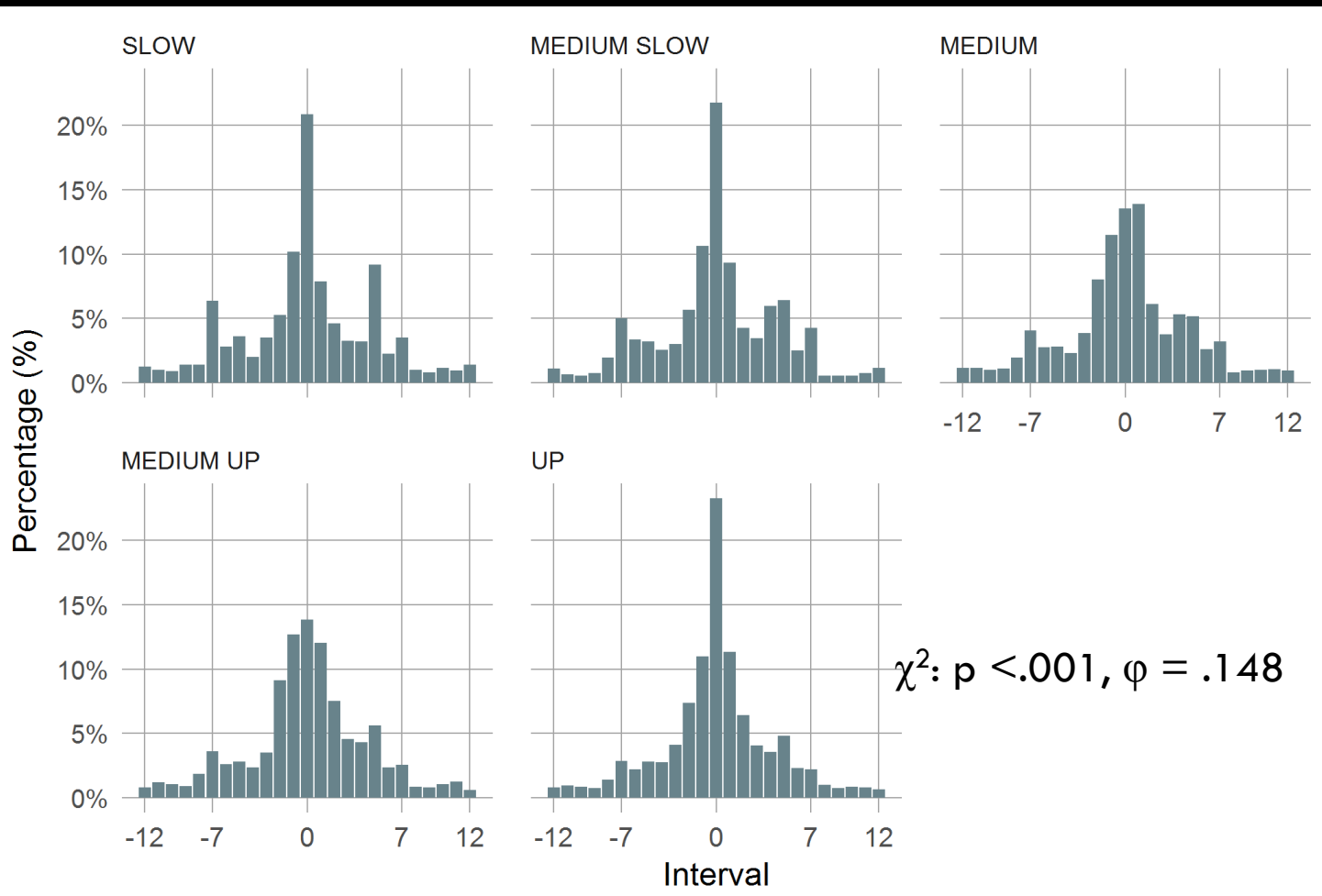


CPC CONSONANCE / TEMPO

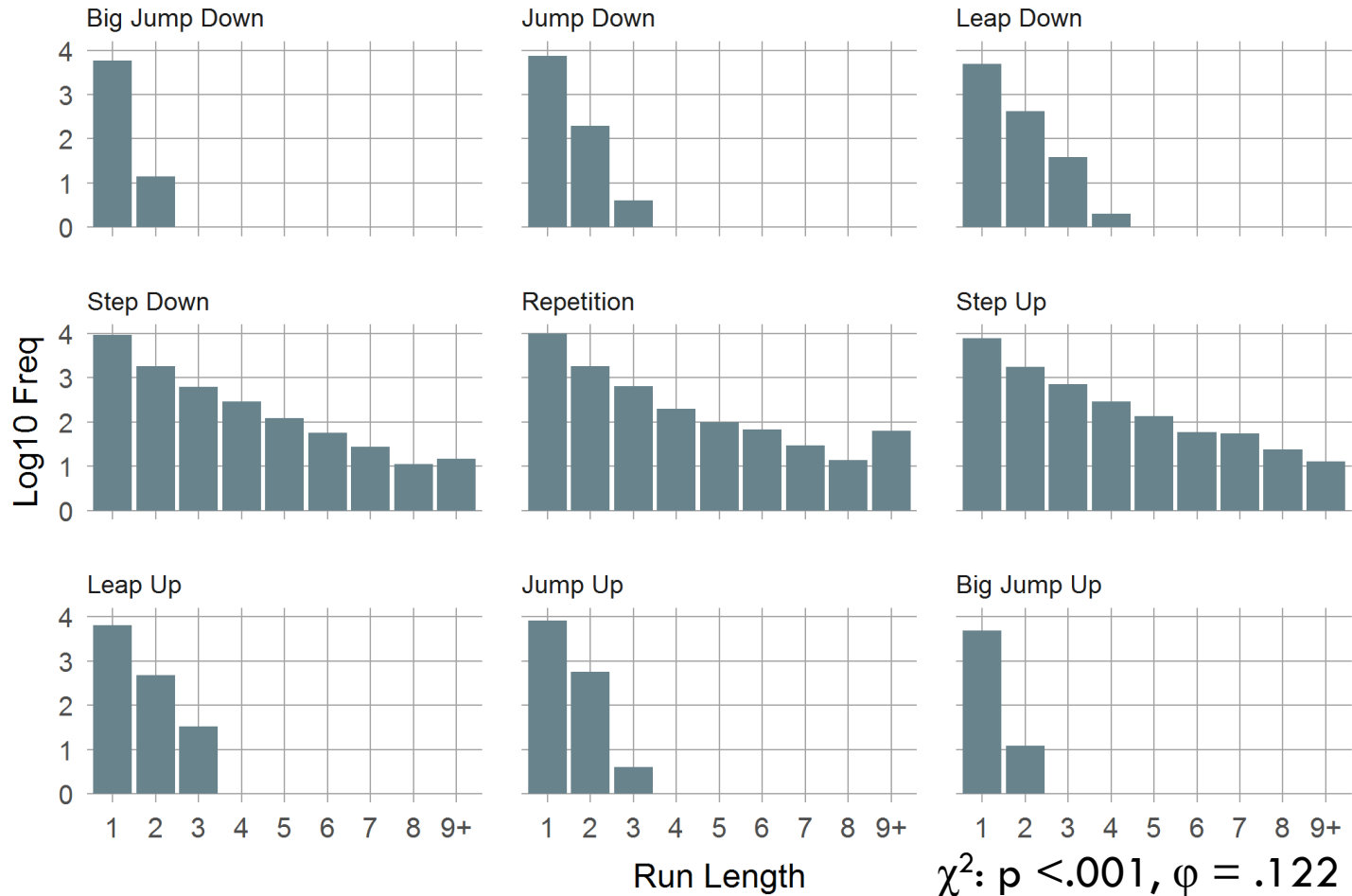


RESULTS: INTERVALS

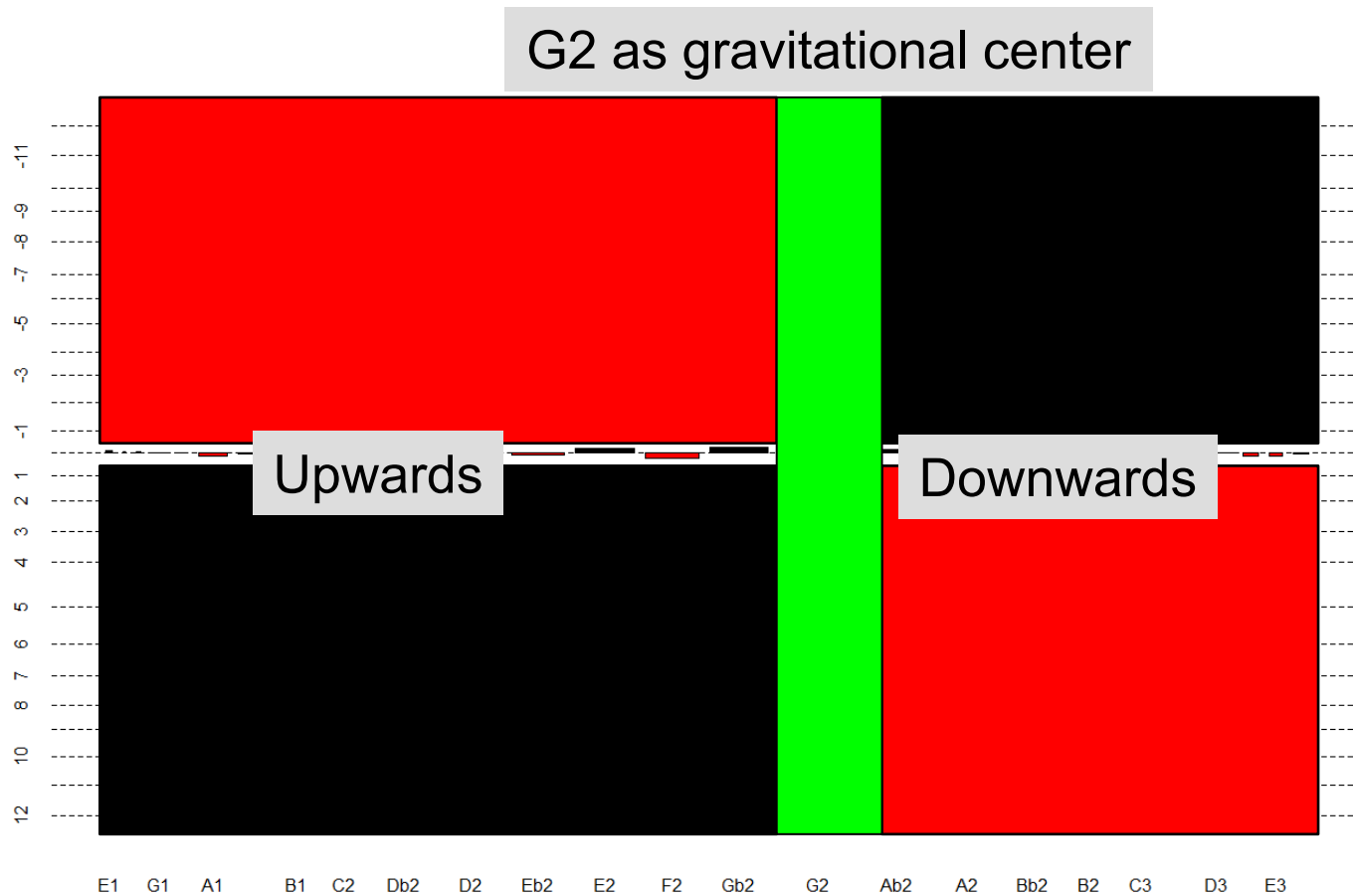
INTERVALS: TEMPO CLASS



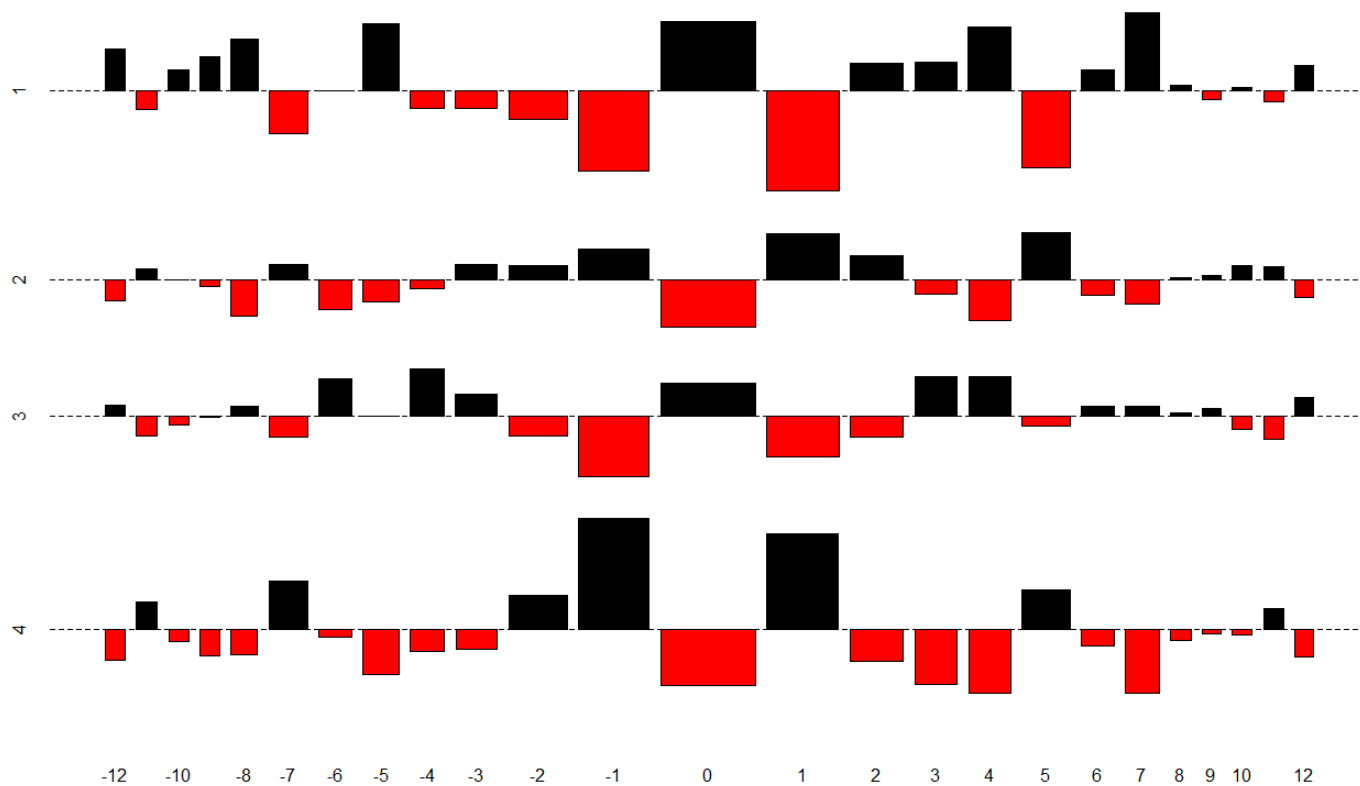
INTERVALS: RUN LENGTHS



INTERVAL X PITCH MATRIX



INTERVAL X BEAT MATRIX

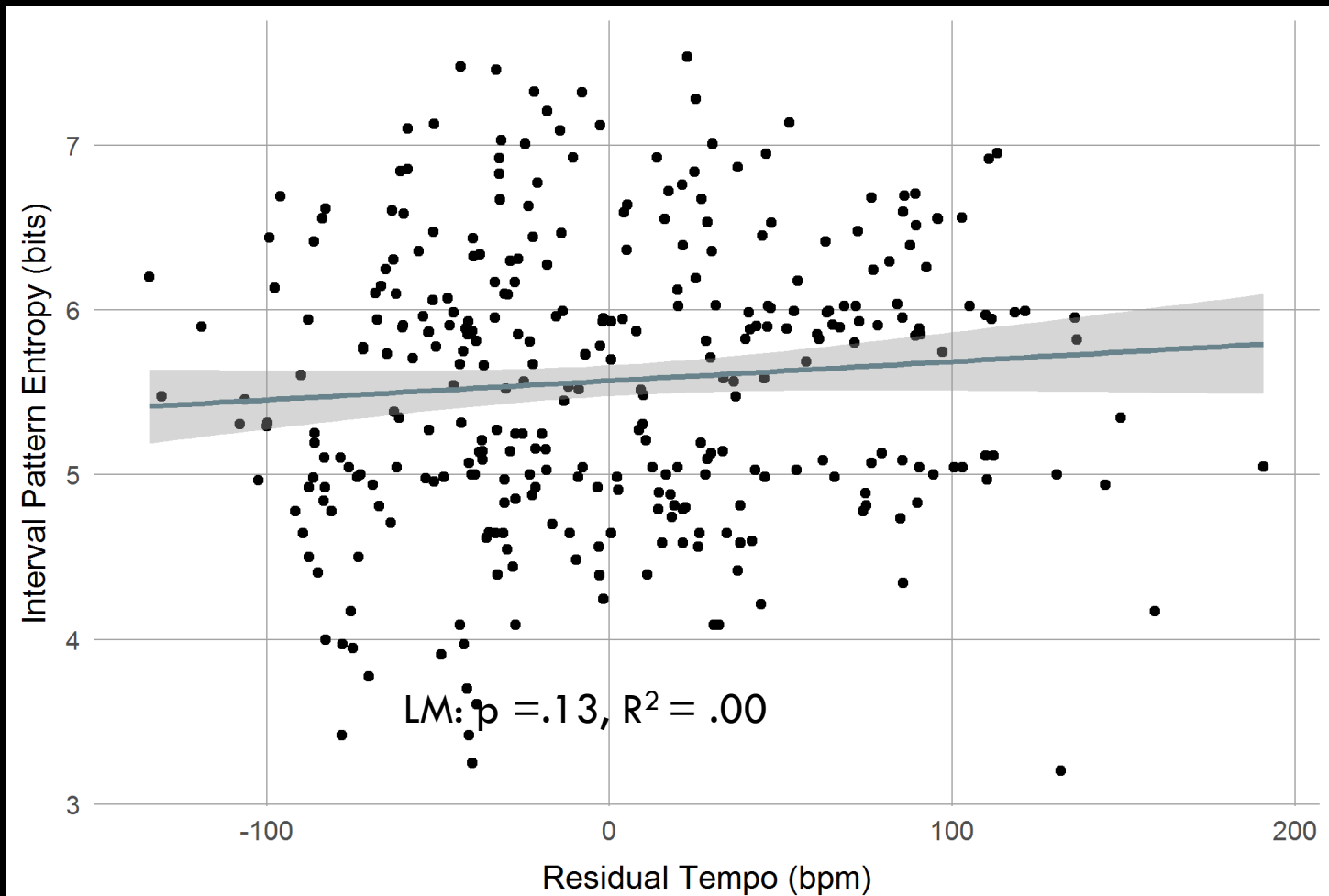


RESULTS:

INTERVAL PATTERN ENTROPY (IPE)

- For each (four-beat) bar determine (4-element) interval pattern.
- Define Interval Pattern Entropy (IPE) as Shannon entropy over the distribution of pattern frequencies: $H = - \sum p \log_2 p$.
- Mean $H_{\text{norm}} = H / \log_2(\text{bar count}) = .97$.
- $\text{IPE} \sim \text{Bar Count}$, $\text{Bar Count} \sim \text{Tempo} \rightarrow \text{control for Bar Count}$.

IPE / RESIDUAL TEMPO



SUMMARY

- Empty strings most frequent (as far as we can tell).
- G2 as gravitational center.
- Most frequent chord pitch classes: root, fifth, third, minor/major second, leading tone.
- The more seldom a chord root, the more players stick to primary chord tones.
- CPC consonance decrease with tempo: higher chromaticism, lower precision in laying-out the chords.

SUMMARY

- Small intervals prevail, mostly repetitions, semitones, whole-tones (56%).
- Repetitions less often used in medium and medium up tempos.
- In slow and medium slow tempo rarely true walking.
- Interval sequence often angular. (Run lengths of interval categories are short, travelled distance and pitch range per bar are independent $r = .0$, $p < .001$).

SUMMARY

- Number of different bar-wise interval patterns large (mean normed Entropy = .97)
- Median of max. rel. frequency of interval and CPC patterns across all solos is about 6%: Low redundancy, high variability.
- Use of interval patterns does not increase with residual tempo.

CONCLUSION

- Create lines beyond basic root and fifths by filling the spaces with step-wise motion (reason why walking bass was invented?).
- Step-wise motion is easiest to play on the bass.
- Frequency of intervals roughly proportional to playing difficulty.
- Usage of empty strings and tone repetitions to ease task.
- Patterns are present but not dominant.
- Bass lines in high tempo are more chromatic, but also harmonically less precise and using more tone repetitions.
- Bass players keep creativity, no falling back on patterns.



THANK YOU!

IPE / RECORDING YEAR

