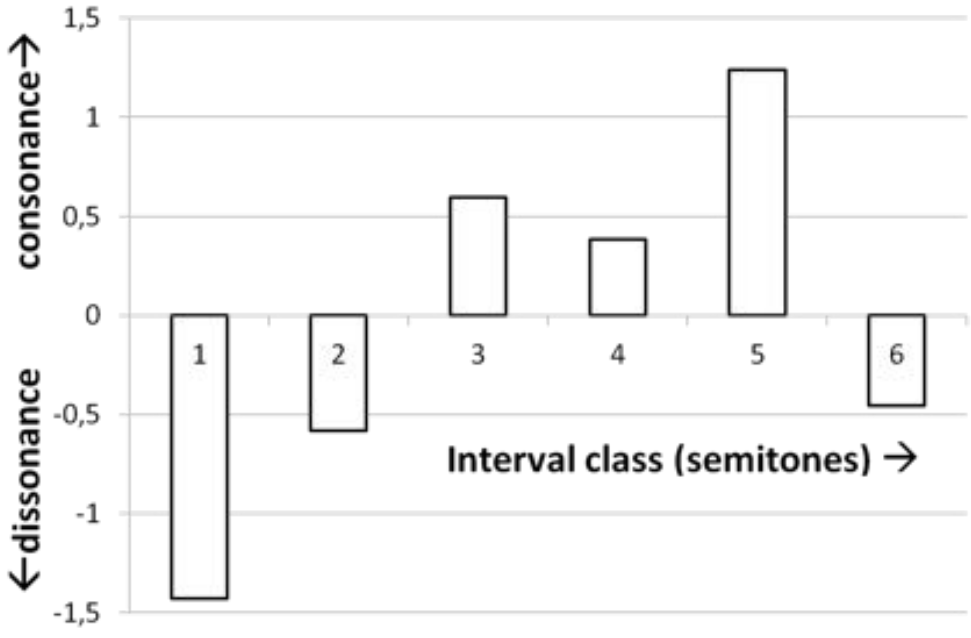
Roughness models

Pc-set	012	013	014	015	016	024	025	026	027	036	037	048
Inversion		023	034	045	056		035	046			047	
#semitones	2	1	1	1	1	0	0	0	0	0	0	0
#tritones	0	0	0	0	1	0	0	1	0	1	0	0
sum	2	1	1	1	2	0	0	1	0	1	0	0

C/D (roughness?) of interval classes

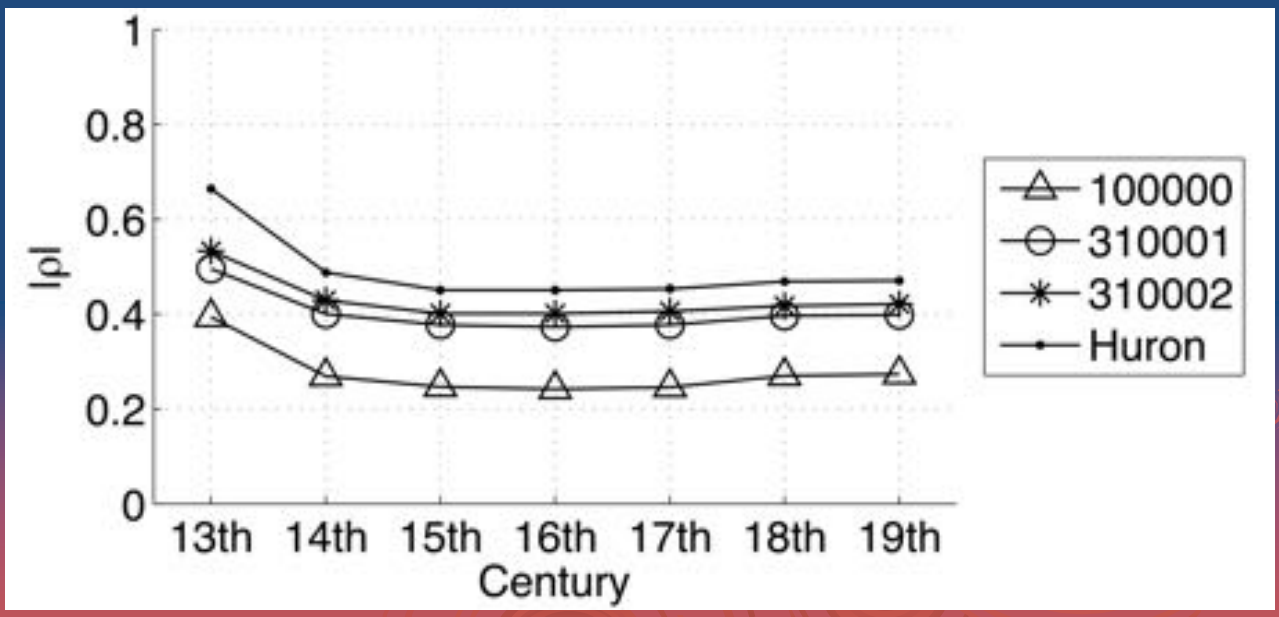
convergent evidence from different sources



Huron, D. (1994). Interval-class content in equally tempered pitch-class sets: Common scales exhibit optimum tonal consonance. *Music Perception, 11,* 289-305.

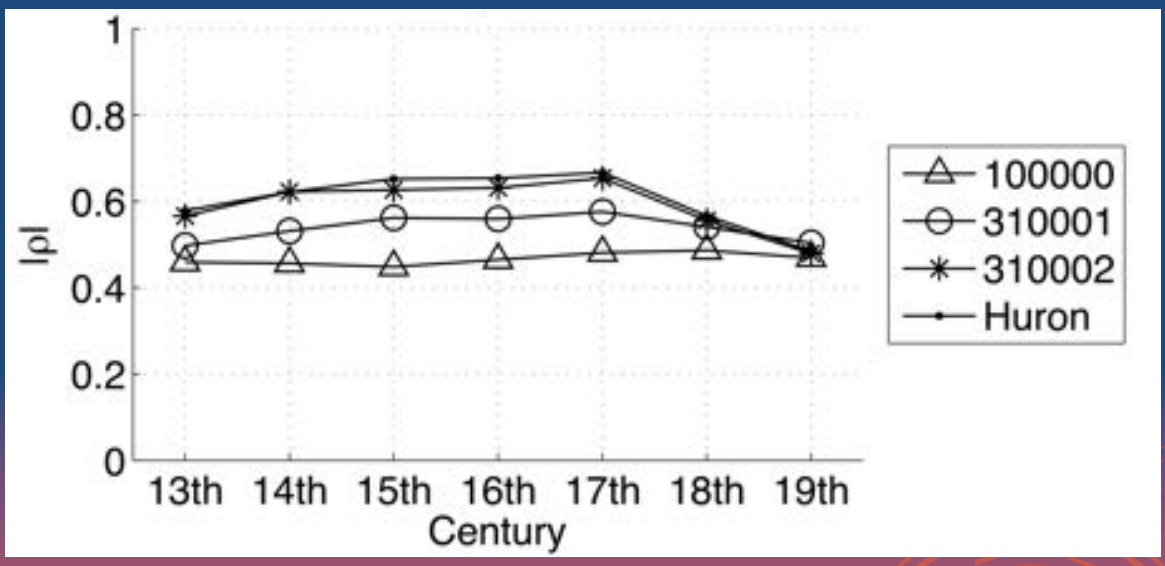
Comparison of roughness models: Unprepared trichords

Correlation coefficient between chord count and model prediction over 19 Tn types

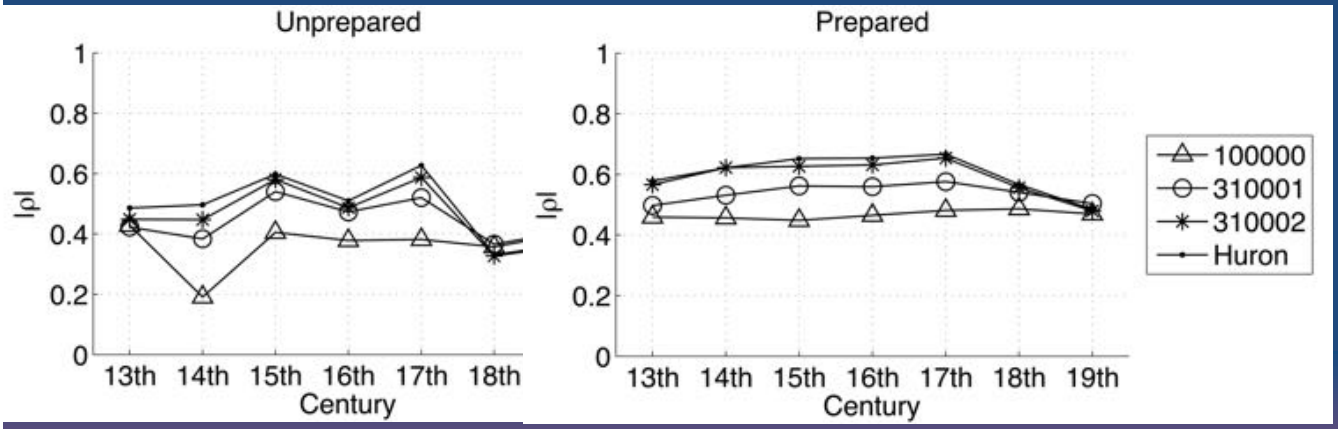


100000 etc. are interval vectors. See Allen Forte (1973) *The Structure of Atonal Music*

Comparison of roughness models: Prepared trichords



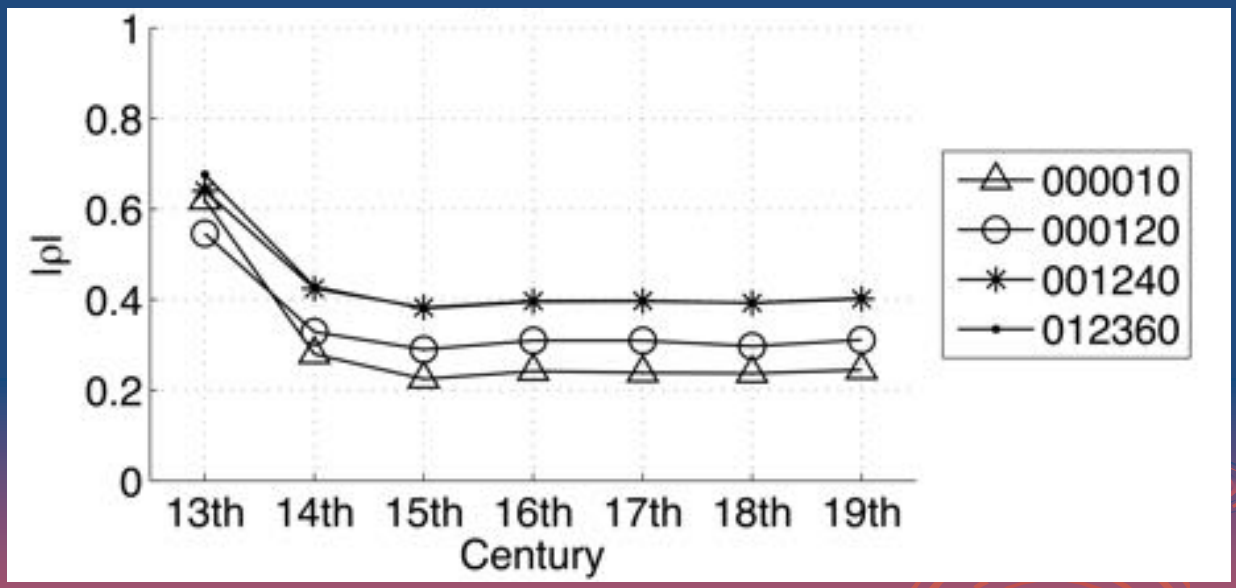
Comparison of roughness models: Tetrachords



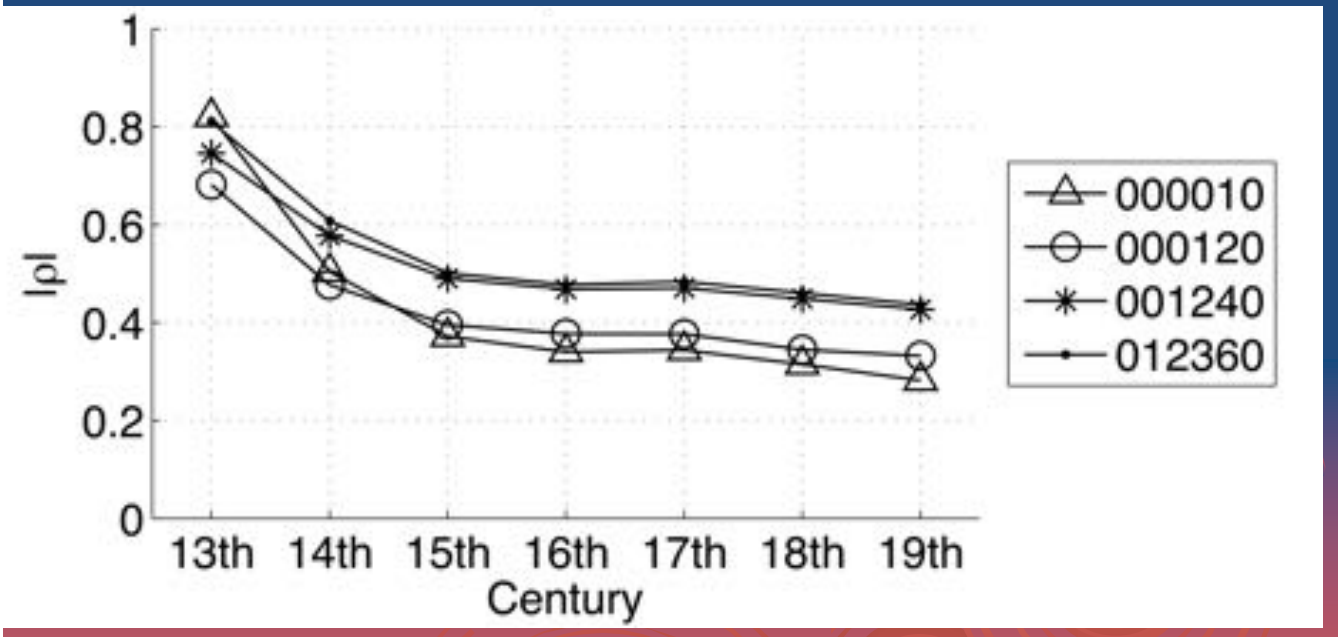
Harmonicity: A simple model

Pc-set	012	013	014	015	016	024	025	026	027	036	037	048
Inversion		023	034	045	056		035	046			047	
# Fourths	0	0	0	1	0	0	1	0	1	0	1	0

Comparison of harmonicity models: Unprepared trichords



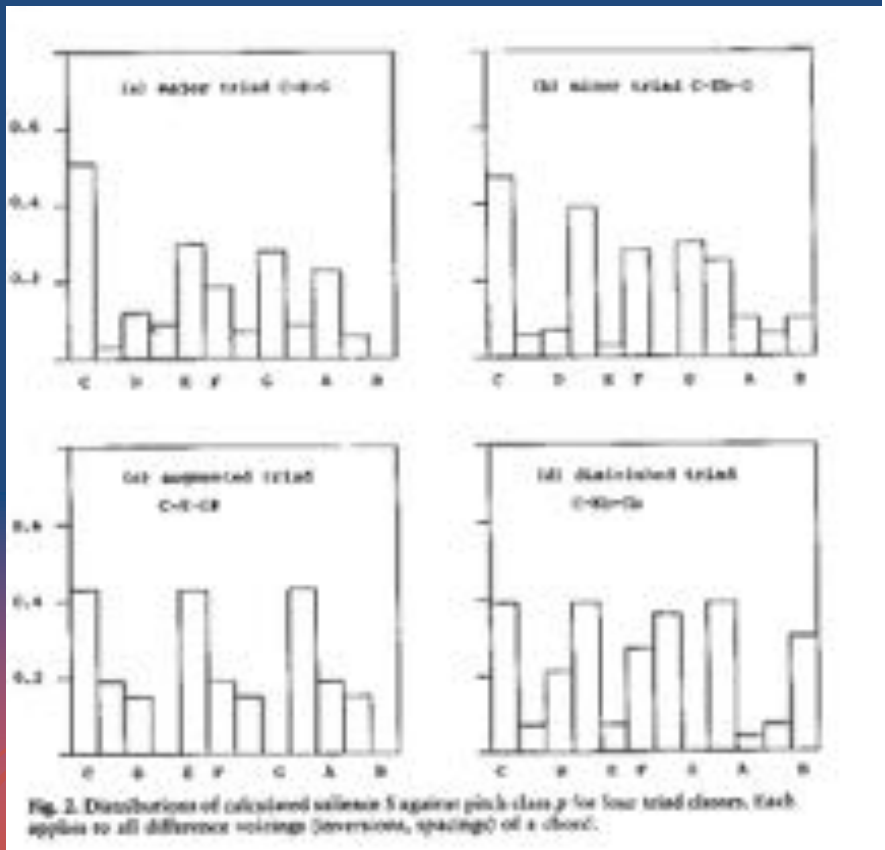
Comparison of harmonicity models: Prepared trichords



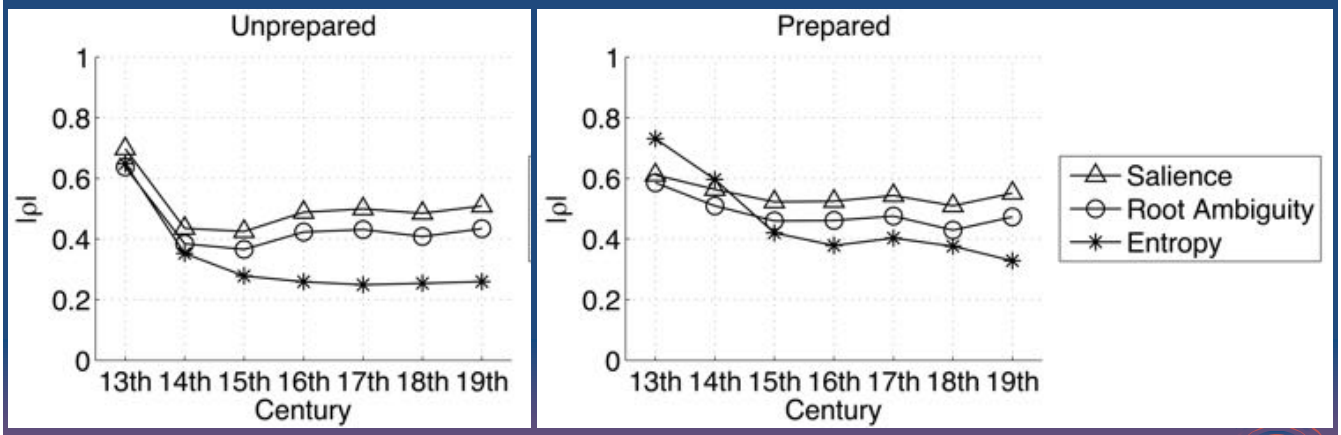
Another measure of harmonicity

Parncutt, R. (1988). Revision of Terhardt's psychoacoustical model of the root(s) of a musical chord. *Music Perception, 6*, 65-94.

Predicted pitch salience →

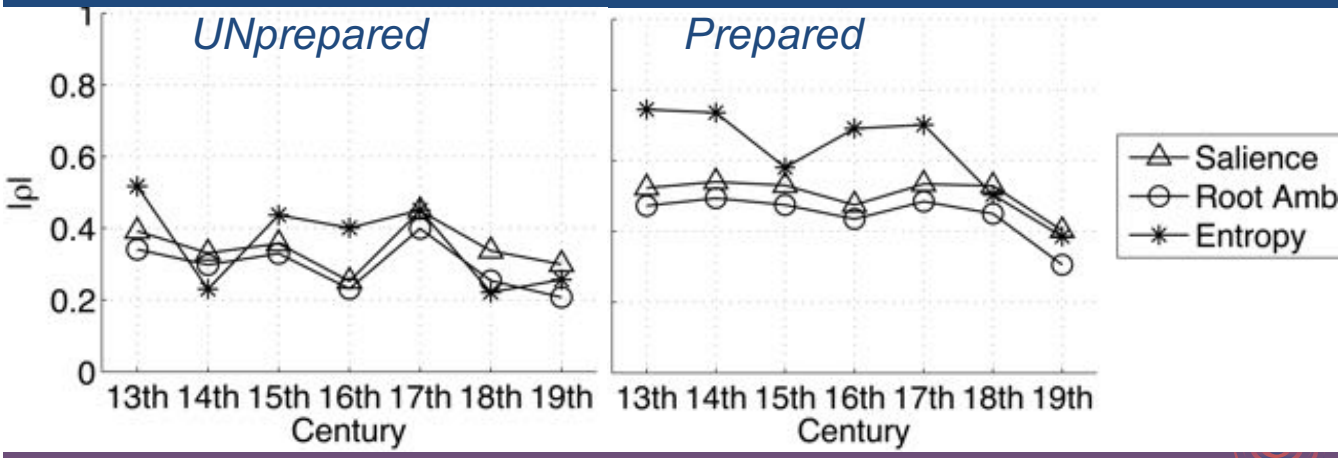


Comparison of virtual pitch salience models: Trichords



- Salience (Parncutt, 1988)
- Root ambiguity (Parncutt, 1988)
- Entropy as defined in statistical mechanics (Andreas Fuchs, personal communication

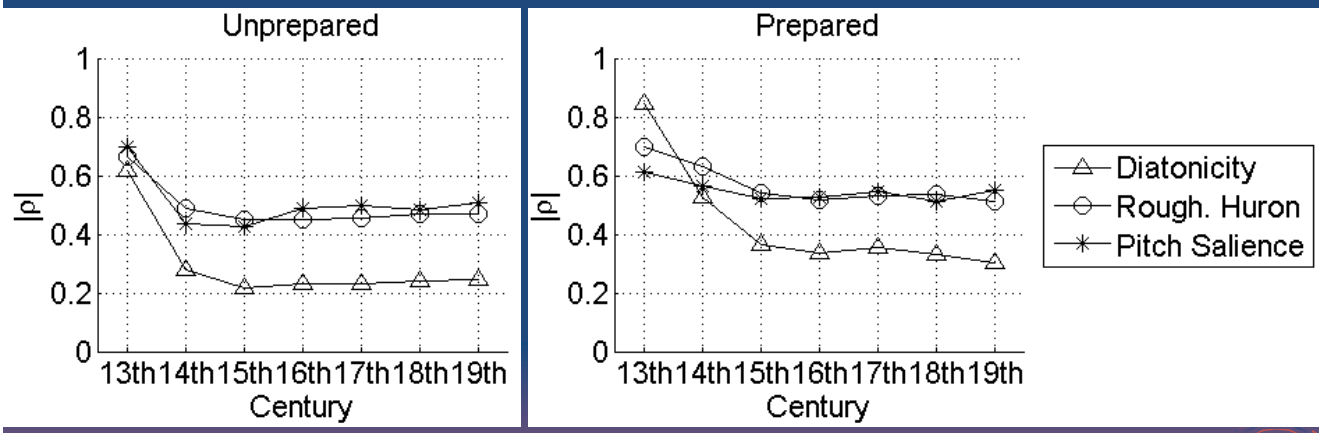
Comparison of virtual pitch salience models: Tetrachords



Diatonicity model

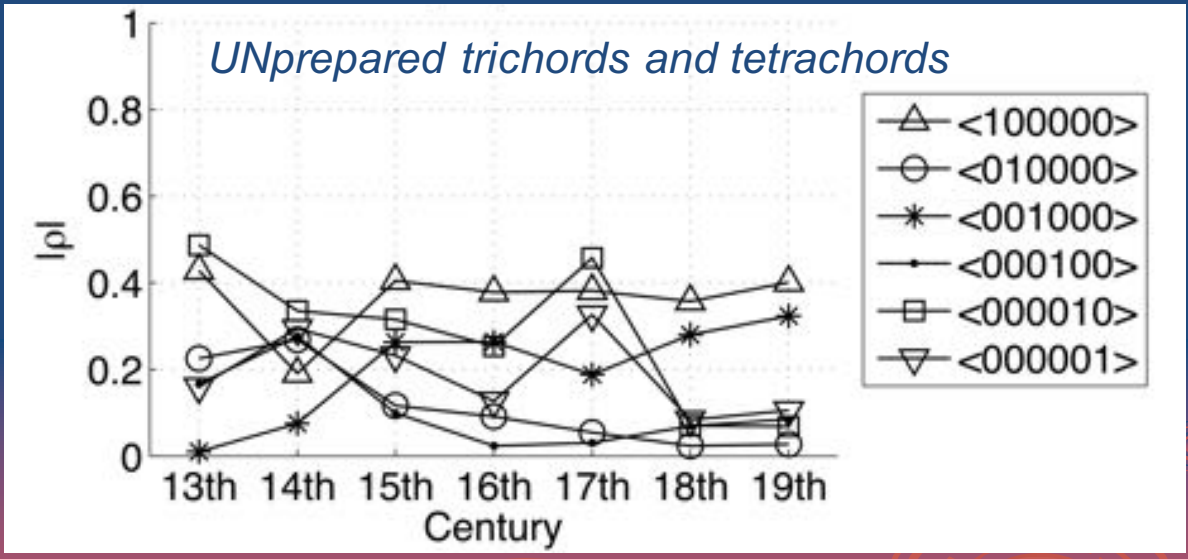
Pc-set	012	013	014	015	016	024	025	026	027	036	037	048
Inversion		023	034	045	056		035	046			047	
Diatonicity	0	2	0	2	1	3	4	1	5	1	3	0

Comparison of 3 main models: Trichords



Which interval determines C/D?

Correlation coefficient between predictions and prevalence



Most important intervals are m2 (1) and P4 (5)

Vertical consonance in the 13th-16th Centuries

Results

Prevalence of vertical pc-sets depends on *roughness*, *harmonicity* and *familiarity*

- less on diatonicity
- less on voice leading

This applies to pre-tonal music!

- "Sonority" was perceived long before theorists talked about it.

Part 2

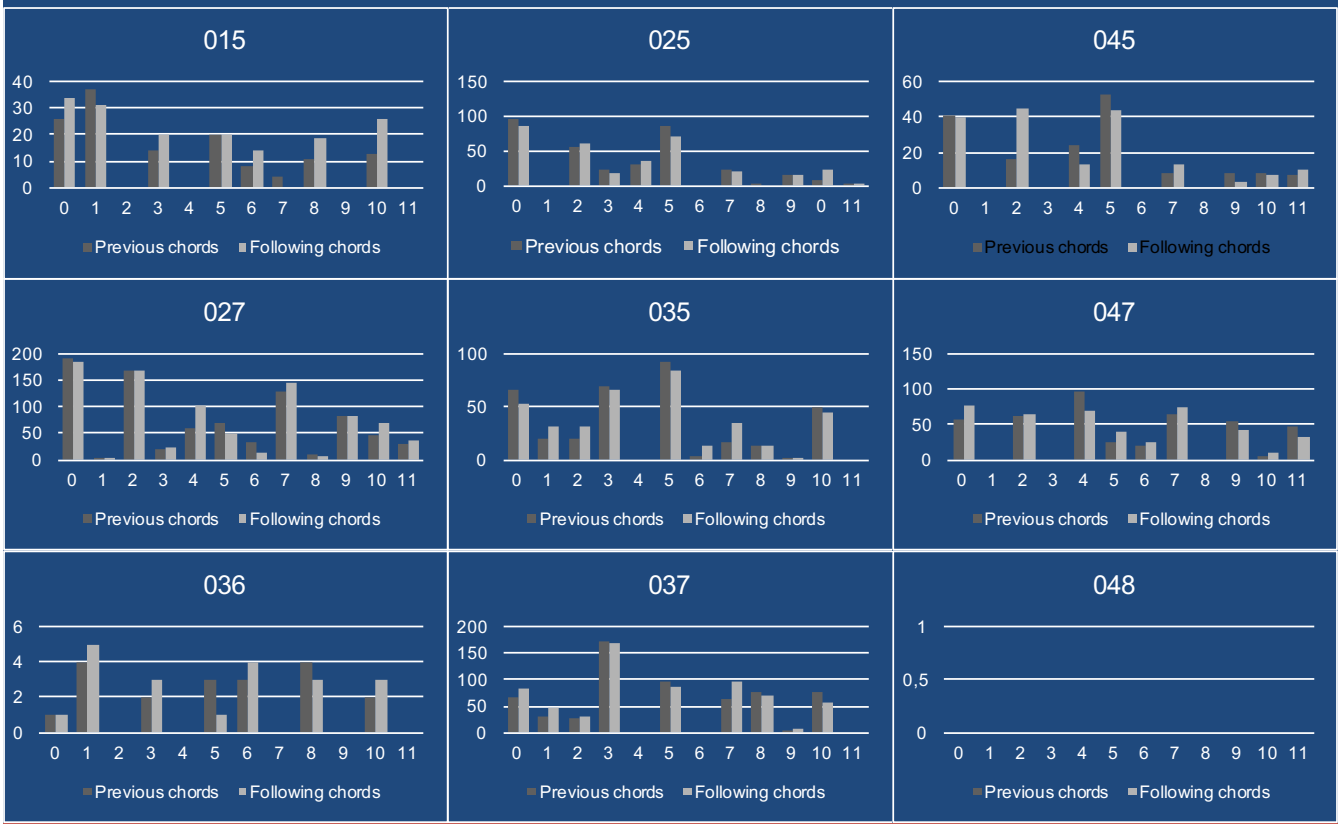
Horizontal / successive C/D

How often does a given pitch class precede or follow a given chord?

→ Profiles of preceding and following tones

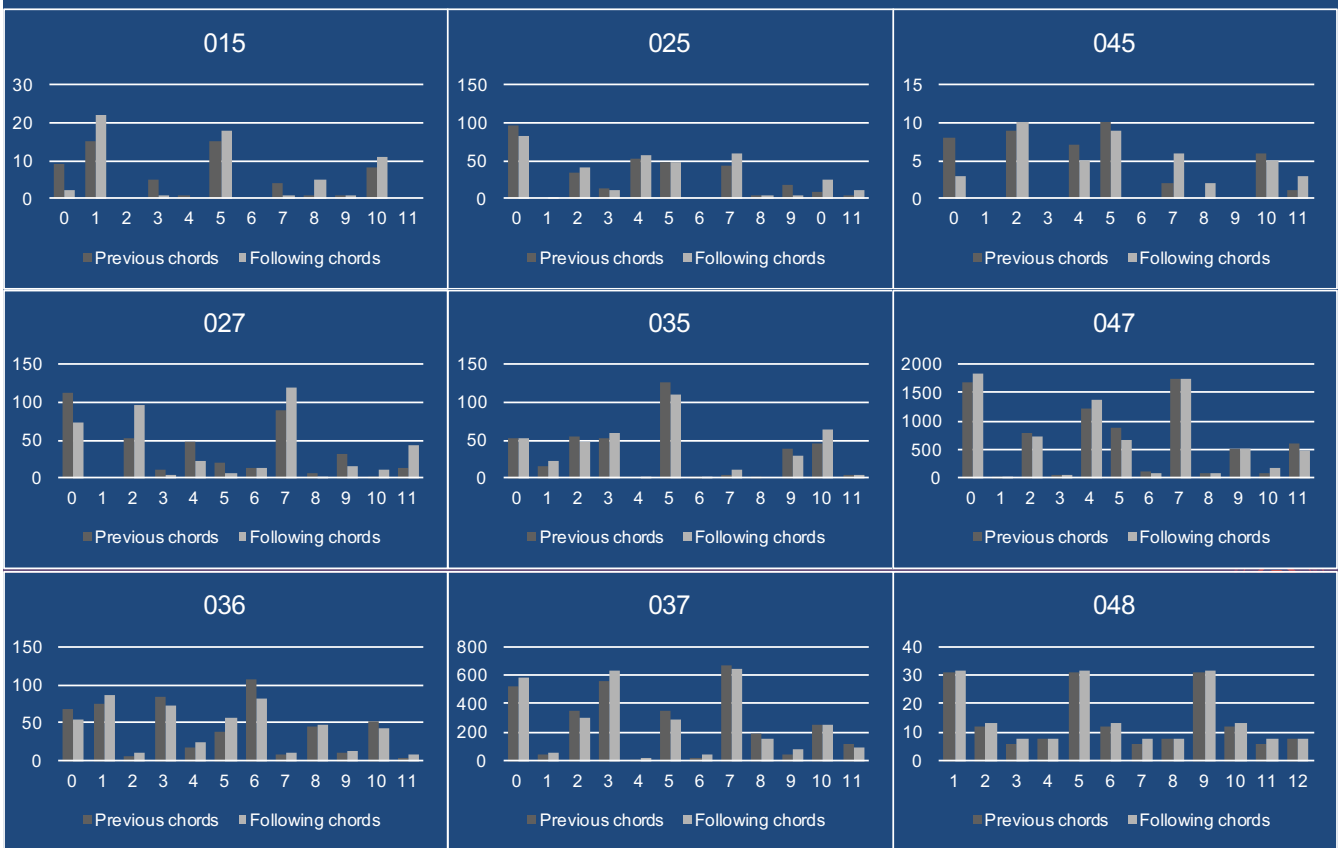
13th century

Tones immediately preceding and following each Tn-type



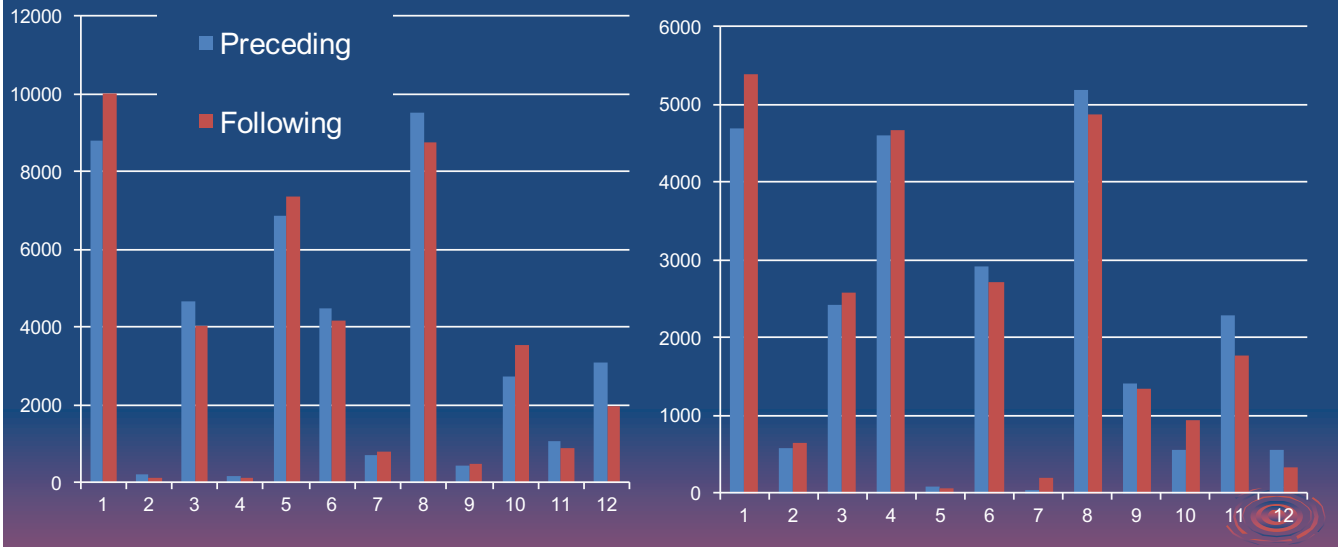
19th century

Tones immediately preceding and following each Tn-type



Major and minor triads

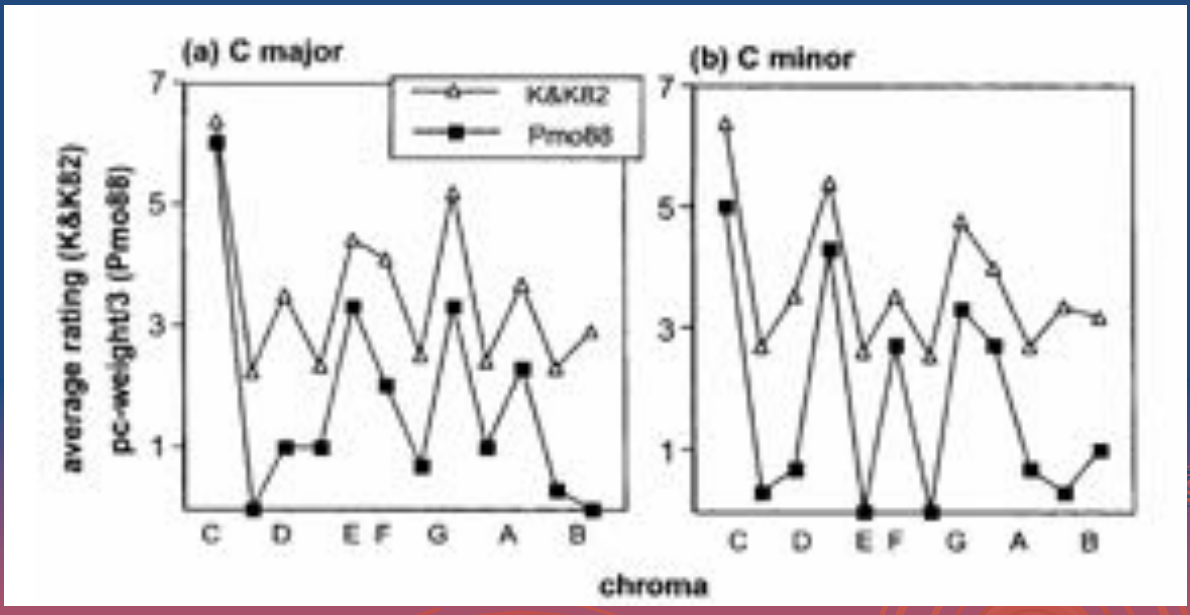
Immediately preceding and following tones, all centuries



Little difference between preceding and following
Not so much difference between centuries
→ Profile depends on the sound of the chord itself?

Tonal stability and pitch salience in the tonic triad

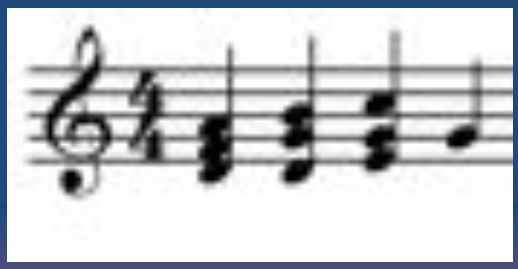
Parncutt, 2001, 2011

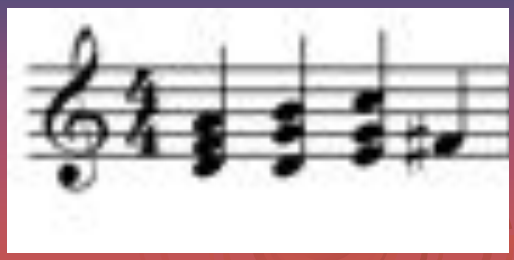


Δ Krumhansl's key profiles ■ calc. pitch salience in tonic triad
→evidence that tonic in MmT is a triad, not a tone

Krumhansl & Kessler 1982

How well does the final tone go with the preceding progression?





Data analysis

For each chord, divide profile into:

- 3 chord tones
- 9 non-chord tones

Initial results:

- chord tones > non-chord
- significant variation within both

Of the 3 chord tones:

Q: Which are more likely to be held or repeated?

A: Conventional chord-roots

- Yes: 015, 027, 035
- No: 025, 036
- Maybe: 047, 037, 045

Of the 9 non-chord tones:

Which are more likely to precede or follow?

- Diatonic tones
- 5^{th}-related tones
- Missing fundamentals
- Completion tones

Result:

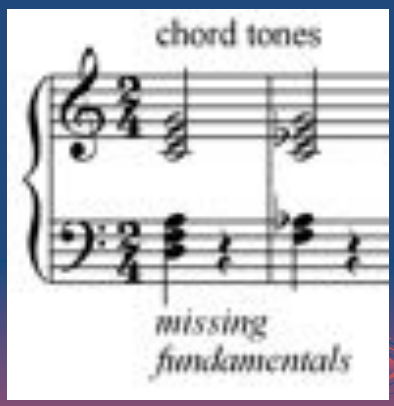
All four contribute significantly.
They contribute in this order.

Missing fundamentals in major and minor triads

A quick octave-generalized account

C major = CEG

- E and G are harmonics of A
- C and G are harmonics of F
- C and E are harmonics of D



C minor = CEbG

- C and Eb are harmonics of Ab
- C and G are harmonics of F

Systematic comparison of 4 theories

for profiles of nine non-chord tones

Chord	Missing fundamentals	5th-related tones	Completion tones	Diatonic tones
015	10, 6, 3, 8, 9, 2, 4, 7, 11	6, 7, 8, 10, 2, 3, 4, 9, 11	8, 10, 9, 3, 7, 6, 2, 4, 11	3, 8, 10, 6, 7, 2, 4, 9, 11
025	10, 7, 1, 8, 4, 3, 6, 9, 11	7, 9, 10, 1, 3, 4, 6, 8, 11	9, 8, 10, 7, 3, 4, 1, 6, 11	7, 9, 10, 3, 4, 8, 11, 1, 6
027	5, 10, 3, 8, 4, 9, 1, 6, 11	5, 9, 1, 3, 4, 6, 8, 10, 11	5, 4, 10, 9, 3, 6, 1, 8, 11	5, 9, 4, 10, 3, 11, 6, 8, 1
035	8, 10, 1, 11, 2, 7, 4, 6, 9	10, 7, 8, 1, 2, 4, 6, 9, 11	9, 8, 7, 10, 2, 1, 4, 6, 11	10, 7, 8, 1, 2, 6, 9, 4, 11
036	8, 11, 5, 2, 1, 4, 7, 9, 10	1, 5, 7, 8, 10, 11, 2, 4, 9	8, 10, 9, 11, 1, 7, 2, 4, 5	1, 5, 8, 10, 2, 4, 7, 9, 11
037	5, 8, 11, 2, 9, 1, 4, 6, 10	2, 5, 8, 10, 1, 4, 6, 9, 11	10, 9, 8, 2, 5, 11, 1, 4, 6	5, 10, 2, 8, 1, 9, 4, 6, 11
045	10, 9, 1, 2, 8, 6, 3, 7, 11	7, 9, 10, 11, 1, 2, 3, 6, 8	9, 8, 7, 10, 2, 11, 1, 3, 6	2, 7, 9, 10, 11, 1, 3, 6, 8
047	9, 5, 2, 3, 8, 6, 1, 10, 11	2, 5, 9, 11, 1, 3, 6, 8, 10	10, 9, 11, 2, 5, 1, 3, 6, 8	2, 9, 5, 11, 6, 10, 1, 3, 8
048	1, 5, 9, 2, 6, 10, 3, 7, 11	1, 3, 5, 7, 9, 11, 2, 6, 10	2, 6, 10, 3, 7, 11, 1, 5, 9	1, 2, 3, 5, 6, 7, 9, 10, 11

1. Does the theory contribute significantly?

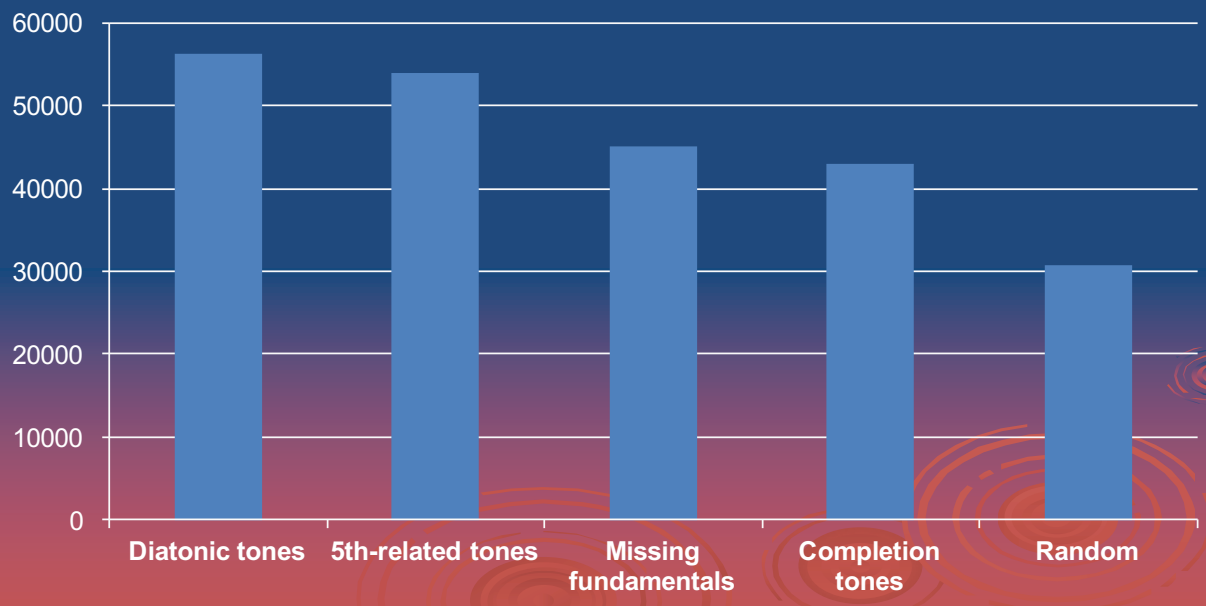
In each cell. compare sum of first four pitches with sum of last four

2. Which theory is the best?

Compare sum of first four across columns

Comparison of four models

…to explain variations in how often 9 non-chord tones precede or follow 8 selected triads. The first 4 columns are the prevalence of the first 4 out of 9 pitches predicted by each model. The last column is 4/9 of the total number of non-chord pitches.



Does perception of musical chords depend on nature or nurture?

Our results suggest: both!

- universal perceptual principles (roughness, harmonic pattern recognition)*
- culture-specific patterns and experience

*Prevalence profiles

- correlate strongly with results of listening experiments
- can partially be accounted for by perceptual universals

Origin of major/minor scales

A simple why-is-the-sky-blue model

	Tonic triad	Missing fundamentals	Leading tone	Avoid consecutive semitones
C major	C E G	F A (D)	B	D
C minor	C Eb G	F Ab	B	D

A psychohistory of MmT

Overlapping stages:

1. Polyphony
2. Stabilization of vertical C/D: smoothness, harmonicity
3. Preference for maj/min triads
4. Stabilization of horizontal C/D: Pitch prevalence profiles
5. Triads become tonics (psychological references)

A psychohistory of MmT

What I deliberately left out…

- Pythagorean ratios
- Voice leading
- Music examples
- Mathematical group theory
- Neuroscience

…not to mention

- Delusions of cultural superiority

Centre for Systematic Musicology

Uni Graz, Austria. Current staff

Annemarie Seither-Preisler
Musical skill transfer

Erica Bisesi
Expression and emotion

Sabrina Sattmann
Pitch perception

Bernd Brabec de Mori
Ethnomusicology

Daniel Reisinger
Student assistant

Lukas Auer
Student assistant