Historical development of tonal syntax: Counting pitch-class sets in 13th-16th century polyphonic vocal music

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Abstract. The evolution of tonal-harmonic syntax in European notated music, from the beginnings of polyphony to the emergence of major-minor tonality, has been the subject of intense historical study. Several authors have also attempted statistical analyses of the frequency of occurrence of specific pitch-time patterns in specific periods or composers. But no-one has compared prevalence profiles across different periods. Here, we estimate the frequency of occurrence of pitch-class sets of cardinality three in small samples of vocal polyphony from the 13th, 14th, 15th and 16th centuries. Throughout this period, sonorities that were later identified as major and minor became more prevalent (major more than minor). The rank order of sonorities was more variable in earlier music, where chords such as CDF or CEbF were quite prominent; in later music, the third and fourth most common chords were suspended and diminished.

Keywords: Pitch-class set, Tn-type, triad, tonality, major, minor

1 Introduction

Major-minor tonality "emerged" in the 16th-17th centuries as major and minor triads became commonplace, not only within chord progressions but also at phrase endings. That may be seen as the result of a long historical process in which compositional trial and error interacted with traditions and rules of contrapuntal writing [2] [4]. Here, we investigate this historical and perceptual process by counting the frequency of occurrence of all pitch-class sets of cardinality three in representative music of different historical periods. It is difficult to compare scores from different historical periods, because several important parameters can vary simultaneously (reliability of written records, notations system, musica ficta). We have attempted to minimize this variation by confining our investigation to 4-part vocal music that is frequently performed and recorded today. Most of the music in the sample is sacred.

2   Method

2.1   Corpus and transcription

We had planned to analyse diverse examples of representative notated music from the 13th to the 16th century. This criterion could not yet be fulfilled for the 13th and 14th centuries for which relatively little notated music exists. Most files were downloaded in MIDI format from internet sources[1] and then transfered to Kern format to enable processing (automatic counting) in Humdrum (`www.music-cog.ohio-state.edu/Humdrum`).

The analyzed works were: **13th century** Perotin: Viderunt omnes, Sederunt; **14th century** Guillaume de Machaut: Messe de nostre Dame (Kyrie, Gloria); **15th century** Dufay: Omnes amici, Missa Ave regina coelorum. John Dunstable: Hymn "Veni creator" for Whitsunday, Veni sancte spiritus. Josquin Desprez: Ave Maria, Salve regina, El grillo (madrigal). Johannes Ockeghem: Missa l'homme armé (Kyrie). Jacob Obrecht: Parce Domine (Motet); **16th century** Orlando de Lassus: Matona mia cara (madrigal). Palestrina: Dies sanctificatus, Adoramus Te, Hodie Christus natus est, Missa brevis (Credo). Missa aeterna Christi munera.

In the computer transcriptions, all pitches have been assigned to the 12-note chromatic scale, which allows us to count pitch-class sets[2]. The problem of musica ficta is not addressed in this preliminary analysis.

2.2   Analysis

Our analysis is confined to pitch-class sets of cardinality three (sets of three pitch classes). According to Forte [3], there are twelve such sets that do not map onto each other by transposition. Five of these sets are symmetrical in the sense that their intervallic inversions are the same (e.g. the set 3-1, which comprises intervals 0, 1 and 2 semitones above a reference pitch). The other seven are not symmetrical, so they comprise two different chord types (e.g. 3-11, which comprises the minor and major triads). The different inversions are commonly referred to Tn-types. There are 19 Tn-types of cardinality three.
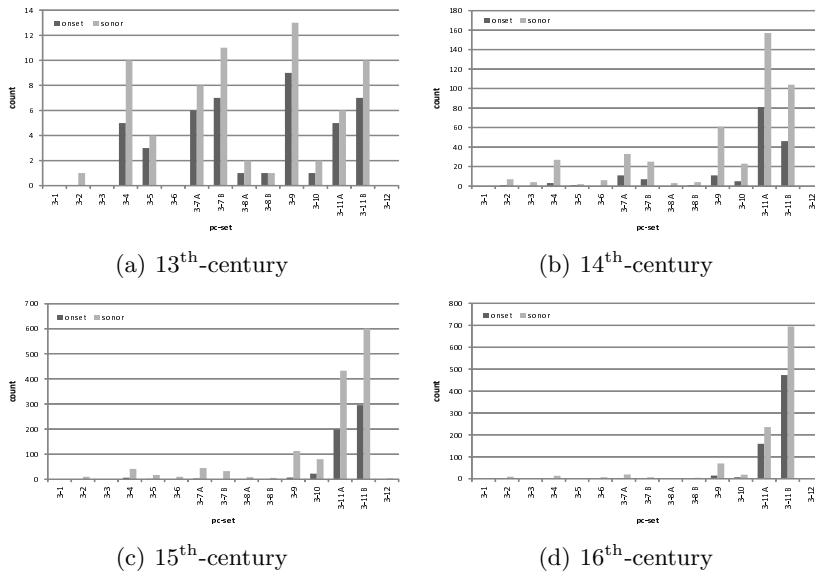
In our analyses, a given Tn-type was considered to occur when either (i) the onsets of the tones sounded simultaneously, called "onset" in the figures below, or (ii) one or two of the tones sounds and the other one or two sounds are held over from the previous sonority, called "sonor".

3   Results

Results from our 13th-century sample are shown in Fig. 1(a). The numbers on the vertical axis make it clear that the sample is too small to claim statistical

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[1] Choral Public Domain Library (`www2.cpdl.org`); Kern library (`kern.ccarh.org`); Petrucci Music Library (`imslp.org`)

[2] see for a list of pc-sets `http://solomonsmusic.net/pcsets.htm`

(a) 13th-century

(b) 14th-century

(c) 15th-century

(d) 16th-century

Fig. 1. Pitch-class set counts for the different time periods. The dark bars ("onset") show the number of times the pc-set occurs with three simultaneous onsets. The grey bars ("sonor") additionally include vertical occurrences of the pc-set in which one or two of the three tones are held from the previous sonority.

significance. Moreover, the sample can hardly be regarded as representative since it includes only two pieces by a single composer, Perotin (see above list). Tentatively we can say that the most common pc-sets of cardinality three in these pieces are 3-7 (in semitones: 025 or 035, e.g. CDF or CEbF) and 3-11 (today's major and minor). There are also several examples of 3-9 (suspended triad 027) and 3-4 (015 or 045).

Our 14th-century sample is confined to extracts from a Mass by Machaut Fig. 1(b). The difference between the Figs. 1 and 2 reflects that Machaut wrote 3-11 sonorities more often than Perotin, and fewer of 3-4 (015, 045), 3-7 (025, 035) and 3-9 (027). In our Perotin sample, several examples of 3-5 had occurred in passing on weak beats, but 3-5 is generally avoided by Machaut.

Fig. 1(c) is the first for which counts are so high that we can make clear stylistic claims. The dominance of major and minor triads over all other possibilities is clearer in the 15th than the 14th century. There are also more major than minor triads - similar to Eberleins [2] analysis of 18th- and 19th-century music. Next in rank order are 3-9 (027, suspended) and 3-10 (036, diminished).

In the 16th century (Fig. 1(d)), the stylistic differences to the 15th-centuries lie not so much in the individual sonorities, but how they are joined together (voice-leading patterns). Consistent with the hypothesis of [4] that the emergence of major-minor tonality in the 16th-17th centuries was only possible after the sound of major-minor triads had become highly familiar to Western ears in the

15th- 16th centuries. The rank order of the four most common Tn-types in Fig. 1(d) - major, minor, suspended, diminished - is consistent with the theory [5] that the main psychological components of consonance/dissonance are fusion and roughness, of which fusion is more important.

4   Conclusions

This paper is exploratory and has primarily confirmed predictions that could have been made on the basis of intuitive theoretical and practical knowledge of the repertoire. Sonorities that were later identified as major and minor became more prevalent throughout the four centuries under consideration, with major more prevalent than minor. The dominance of major and minor triads in root position in the 15th-16th centuries cannot be explained purely on the basis of older conventions of voice leading, even though the composers in question consciously applied those conventions. Presumably, the new principles of chord construction that were discovered and explained by the music theorists of the 17th century were already being applied intuitively by composers of the 15th and 16th centuries. This hunch is consistent with an approach to music history that emphasizes the role of hearing and psychology by comparison to contrapuntal theories, rule systems and Pythagorean ratios.

   Since major-minor tonality now dominates world music, it is reasonable to ask how the system emerged, which will help us to gain a new, psychologically based understanding of its inner workings and apparently universal appeal. The striking dominance of major and minor in the 16th century is consistent with the idea that they are the foundation upon which major-minor tonality was built. These sounds had to be familiar to western ears before they could become tonic triads in the emerging tonal system. The increasing stability of the rank order of sonorities over these four centuries is consistent with the idea that a more stable tonal system was emerging by a process of perceptual trial and error. Composers and improvisers were constantly trying out new pitch combinations and testing them by ear. Sounds that listeners, composers and performers liked were more likely to "survive".

References

1. Burns, E. M. Intervals, scales and tuning. In: D. Deutsch (ed.), Psychology of Music, 2nd. ed., pp. 215-264. Academic Press, San Diego (1999)
2. Eberlein, R.: Die Entstehung der tonalen Klangsyntax. Frankfuft/Main: Peter Lang (1994)
3. Forte, A.: The Structure of Atonal Music. Yale University Press, New Haven (1977)
4. Parncutt, R.: The tonic as triad: Key profiles as pitch salience profiles of tonic triads. Music Perception, Vol. 28, No. 4 (April 2011) (pp. 333-366)
5. Parncutt, R., Hair, G.: Consonance and dissonance in theory and psychology: disentangling dissonant dichotomies. Journal of Interdisciplinary Music Studies (accepted)