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## The *Supplementum* in Motets: Style, and Structure

### ABSTRACT

#### Background

One common task in computational music analysis is the use of key-finding algorithms when examining common practice period music (or music that was composed between 1600-1900). The notion of key does not exist in earlier eras. Musicians in the Renaissance categorized music according to modes. A mode is type of scale with a set of characteristic melodic behaviors. Would it not be great to build a mode finding algorithm? To build a mode-finding algorithm, we need to evaluate methods of how to determine modal characteristics. One of the methods used to determine mode is finding the "final pitch." But what is the final pitch of a polyphonic work? Is it the tenor? Is it the root within the final cadence? We need to look at the final cadence of a composition. However, sometimes the final cadence occurs before the end of a composition, and other post-cadential musical material is added afterwards. The model is called a *supplementum*. When a piece has a *supplementum*, the sonority at the final cadence is not necessarily the pitch of the final sonority.

Joachim Burmeister describes the *supplementum* in his *Musica poetica* (Burmeister, 1608). His conceptualization is picked up by other music theorists, and is identified by different terms such as the *manubrium* in Johannes Nucius's *Musices poeticae* (Nucius, 1613), which occurs in "virtually all motets," and the *paragoge* in Joachim Thuringus's *Opusculum bipartitum* (Thurignus, 1624) which is nowadays employed in "all compositions" (Bartel, 1997).

The *supplementum* is a passage two or more measures long, expanding on a "primary" or "secondary" pitch after the final cadence to emphasize its finality (Burmeister/Rivera, 1993). Burmeister clarifies that the *supplementum* is an "elaboration of a final pitch in a stationary voice," and that added pitches in other voices should create "consonances with it" (Burmeister/Rivera, 1993). Students, Burmeister prescribes, should study examples by master composers, and he provides a complete analysis of Lassus's "In me transierunt" (Burmeister/Rivera, 1993) to lead the way. Lassus's motet includes a *supplementum*, and Claude Palisca provides an annotated version of Burmeister's analysis of the composition (Palisca, 1972).

Contemporary scholars complement Burmeister's definition and show *supplementa* in analyses of works by other composers. Julie E. Cumming labels a *supplementum* at the end of Isaac's "Inviolata integra et casta es Maria" (Cumming 2011). Martin Just remarks on a *supplementum* in the "Circumdederunt me (III/2)" of Jean Richafort's Requiem (Just, 1990). Bernhard Meier points to a *supplementum* in Claudio Merulo's "Toccata I, 1: *Primo tono*" (Meier, 1977). Patrick McCreless identifies a *supplementum* in verse 13 from Lassus's setting of Psalm 143 in "Seven Penitential Psalms" (McCreless, 2008). Peter N. Schubert shows *supple-*

*menta* at the end of Palestrina's motets "Dies sanctificatus" (Schubert, 1993), and "Benedicta sit" (Schubert, 2007), and at the end of Lassus's Kyrrie in "Missa Je suis déshéritée" (Schubert, Lessoil-Daelman, 2013).

#### Aims and repertoire studied

*Supplementa* occur in many types of Renaissance compositions and are quite varied. Therefore, the repertoire had to be condensed to just one type of Renaissance composition, namely the motet. Even at that level of granularity, there are still over 4,000 motets available online. From these 4,000 motets, we examined a corpus of 400 motets written by Josquin, Victoria, Palestrina, Ockeghem, Mouton, and many additional composers active between the years of 1480 and 1620. From the corpus, we developed a catalogue of *supplementa*, allowing me to identify different types of *supplementa*. Considerations were as follows: (1) What types of consonances and dissonances are found? (2) What were the most frequently occurring primary, secondary, or tertiary stationary pitches? (3) What are the most common contrapuntal patterns found in *supplementa*? (4) Are the pitches of the cadential arrival and the final sonority the same? (5) To what extent are these issues coordinated with mode?

#### Methods

The corpus examined consisted of 400 symbolic music notation files, readable by computer software. The corpus only represents a sample size, and was compiled from the ca. 4,000 Renaissance motets freely available online at ChoralWiki <www2.cpd.org/>, the ELVIS Database <database.elvisproject.ca/> (built by the Single Interface for Music Score Searching and Analysis project, or SIMSSA project <simssa.ca> at McGill University), and Stanford University's Josquin Research Project <josquin.stanford.edu/>. The corpus was optimized to contain less than twenty compositions by one composer, so that any one composer would not be favored and skew the extracted data with their respective compositional style.

Only the endings of the motets (or the endings of motet sections, if the motet consisted of more than one section) were parsed (a process known in data science as "masking"), and extracted into a catalogue with the help of music21 (a toolkit for computer-aided musicology developed at MIT <web.mit.edu/music21/>), the VIS Framework (a symbolic music analysis suite also developed by the SIMSSA project at McGill <github.com/ELVIS-Project/vis-framework/>), and the Python Data Analysis Library <http://pandas.pydata.org/>. The extracted catalogue of *supplementa* was placed into a database-style structure called a data frame, from which the five designated considerations could be queried in multiple ways.

## Implications

The process of teaching the computer to identify *supplementa* and compare them, allowed me to gain a large-scale and rigorous understanding of this important element of Renaissance polyphony. From a musicological perspective, we found that historic music theoretical discourse was right about stationary pitches, and *supplementa* lengths, but that it was incomplete concerning *supplementa* always being at the end of a whole piece (or a motet consisting of multiple sections). Historical discourse was also incomplete about *supplementa* always confirming the pitch of a final cadence. Additionally, we could quantify the types of consonances/dissonances favored by composers, and what types of contrapuntal patterns occurred most frequently within *supplementa*. Further, we discovered that there are three structurally different types of *supplementa*, and that the pitch of the cadence is not necessarily the pitch of the final sonority. Finally, we can confirm with my collected data that *supplementa* vary according to mode.

From a computational music analysis perspective, the combination of results will enable us to train the computer to recognize different types of cadences, and different types of *supplementa*. Our corpus and its corresponding dataset can also function as ground truth for supervised machine learning, as we work toward a "mode-finding algorithm" that works for real Renaissance music.

## Keywords

Renaissance, Motets, Supplementum, Counterpoint, Early Music, Polyphony, Structure, Analytical Theory, Music Analysis and New Technologies, Music Analysis and Music Theory, Quantitative Approaches to Analysis, Computational Musicology.

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