

The Rule-of-the-Octave Hypothesis: A Quantitative Study of Tonality in François Couperin's *Concerts*

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ABSTRACT: This article uses methods from digital musicology to examine the relationship between a theory of tonality from the early eighteenth century and the compositional practice of that period. François Campion's *règle des octaves* (rule of the octave), in which specific chords are assigned to each bass note of major and minor scales, is evaluated against a corpus of musical works composed at the same time and in the same country and that contains precisely notated harmony: the *Concerts* by François Couperin. This corpus was compiled in a digital format, annotated, and computationally analyzed using various statistical methods. Our findings suggest that the rule of the octave is to be understood less as a model for scale harmonization and more as a set of expected chords for each bass scale-degree. This is reflected on the level of chord-pairs (or bigrams), which suggests a hierarchical distinction between stable scale-degrees ("notes essentielles" according to contemporary French theory) and soft scale-degrees. We also show that a system of modes differentiated by leap and step, as developed by Johann David Heinichen in his *Schema modorum*, is a useful complement to Campion's version of the rule. Further comparisons with works by Arcangelo Corelli, who acted as a model for Couperin, reveal specific differences in harmonic language. The study thus attempts to corroborate the view of the rule of the octave as a theory of major-minor tonality.

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Introduction

[0.1] This article⁽¹⁾ examines the degree to which an early theory of harmonic tonality corresponds with the patterns found in the music of the same time. François Campion's *règle des octaves* (1716) formulates a rule that claims to define a tonal norm with regard to the most common chords used on the seven degrees of the major and minor scales.⁽²⁾ This "rule of the octave" (RoO) also appears in other theoretical writings of the time and was used not only in the eighteenth but also over the course of the nineteenth century. Today, the RoO is understood in various ways. While some see it primarily as a method of scale harmonization, others view it as a more comprehensive theory of tonal harmony that is also relevant for non-scalar bass progressions (Holtmeier 2007; Nicolas 2019).⁽³⁾ An analysis of historical sources, such as Johann David Heinichen's *Der*

General-Bass in der Composition (1728), provides support for the latter view. As our contribution will demonstrate, the RoO was used not only for scalar bass segments but also as a repertoire of chords suited to express tonality.

[0.2] Even though Campion's *règle* originally came from the context of improvisation and *basso continuo* playing, it spread quickly and is still considered to have theoretical significance. However, the question arises whether the theory holds in compositional practice. We explore this question within a well-defined corpus from one of the most prominent composers of the same time and country as Campion: François Couperin. We will also compare a set of Couperin pieces with a selection of Corelli sonatas in order to highlight their specific stylistic differences and the different appearances of tonal vocabulary.

1. Historical and Theoretical Foundations: The Règle des octaves and the 14 RoO chords

1.1. Historical background

[1.1] Our contribution focuses specifically on the French cultural area in which we encounter a very clear description of the RoO (and from which the term also originated). The paradigm shift from modality to major-minor tonality can be observed in French treatises from the second half of the seventeenth century. While in his *Traité de la composition de la musique* from 1667 Guillaume-Gabriel Nivers presents eight modes (1667, 18–19), around 20 years later the same author restricts himself to the “trois sortes de manieres ou progrez de chant” [three types of styles or progressions of chant] in an attempt to provide a general foundation: the modes are based on the syllables ut, re, and mi, respectively, i.e., major, minor, and Phrygian, in modern terms (Nivers 1689, 150; see also Dodds 2024).

[1.2] Like some authors before him (e.g., Rousseau 1687 and Charpentier 1692), Charles Masson (1699, 10) goes one step further, reducing the number of modes to two, a *mode majeur* and a *mode mineur*, for reasons of learning the art of composition more quickly and more easily.⁽⁴⁾ Drawing on the traditional idea of three *notes essentielles*, Masson describes the main degrees *finale* (1st degree), *mediante* (3rd degree), and *dominante* (5th degree), which he specifies in the bass clef, i.e., as bass notes.

[1.3] The French scale-degree designations, as described by Jean-François Dandrieu (1718, 5), relate the secondary degrees to these three *notes essentielles* with the prefixes “su” (above) and “sou” (below), resulting in the terms *finale*, *sufinale*, *mediante*, *soudominante*, *dominante*, *sudominante*, and *soufinale*. The modes of major and minor as well as the hierarchical differentiation of degrees are the prerequisites for a first harmonic tonal theory that the RoO accounts for. The first datable representation of the RoO in France can be found in François Campion's *Traité d'accompagnement et de composition, selon la règle des octaves de musique* (1716). The RoO also appears in Dandrieu's above-mentioned *Principes de l'Acompagnement du Clavecin* (1718, XXII) and later several times in Jean-Philippe Rameau's *Traité de l'harmonie* (1722, 212, 382, and 399).

[1.4] While the RoO was becoming an increasingly popular theoretical framework across Europe in the late seventeenth century (Menke 2020b, 99), its French incarnations exhibited uniquely complex harmonic thinking, something that becomes evident from sophisticated dissonant chords displaying specific sonic qualities in the *accompagnement*. This contrasts with more contrapuntal Italian variants, represented by Antonio Bruschi's RoO that manifests as three-part consonant counterpoint (1711, 36–37). Other approaches, such as Gasparini's (1722, 58–59) and Heinichen's (1728, 903), were less focused on goal-directed chord progressions, featuring mainly root-position and first-inversion chords, with inversions of seventh chords appearing only on the fourth scale-degree.

[1.5] In France it was typical to use abbreviations for the inversions of the dominant-seventh chord, for instance *accord de la petite sixte* for the $\frac{4}{3}$ chord on the second degree, *accord de la fausse quinte* for the $\frac{6}{5}$ chord on the ascending seventh degree, and *accord du triton* for the chord on the descending fourth degree. Those names are based on the characteristic intervals constituting the chords in question (Christensen 1993, 50). When Rameau applied his idea of *basse fondamentale* to the rule of the octave (e.g., Rameau 1722, 212, 382, and 399), we find a kind of theory behind the theory, or, expressed in Rameau's words, a “*raison*” that explains the common “*experience*” of the RoO.

[1.6] Unlike similar concepts in Italy (e.g., [Bruschi 1711](#)) and Germany (e.g., [Heinichen 1728](#)), the French RoO is based on a complete octave scale and includes several dissonant chords (explained by Rameau as inversions of the seventh chord). The accompanying thoroughbass figures also generally indicate a raised fourth scale-degree (an applied leading tone of the dominant) to be added to the chord over the major scale's descending sixth scale-degree. **Example 1** shows the RoO in the major and minor modes as it appears in two French sources by Campion ([1716](#)) and Dandrieu ([1718](#)).⁽⁵⁾

[1.7] With his *règle des octaves* Campion presents a “general and simple” method for finding the typical and most suitable chord for every scale-degree of a major or minor key (which he calls “octaves”). The RoO therefore can be understood as a general rule for each of the twelve major and minor keys (the 24 “octaves”). The rather short treatise contains only three examples:

- RoO in 12 minor modes in ascending fifths, starting with D minor;
- RoO in 12 major modes in descending fifths, starting with C major;
- and extraordinary chords in minor.

[1.8] Campion first formulates the RoO as a general and simple rule for accompaniment:

To accompany, it is necessary to consider in which of these keys one is, and on which degree, starting to count with the first one, ascending or descending the harmony; this is the surest and easiest way to give the necessary chord, and I do not believe that anything more general and simpler has been given so far.⁽⁶⁾ ([1716](#), 6)

This means that the successful application of the RoO requires the following steps:

- Recognizing the key;
- identifying the degree by counting up or down;
- using the corresponding chord.

[1.9] The RoO shows only chords without any additional non-chordal dissonances (such as suspensions); therefore, it can be understood as a “modernized” way of note-against-note counterpoint (*contre-point simple*), in which the notes added above the bass are determined by their harmony. This is a fact Campion is aware of: “The demonstration of these two plates is done in simple counterpoint, because we can ascend or descend the scales by other chord figures, like sixths or sevenths, and so on” ([1716](#), 10).⁽⁷⁾ Suspensions like 7–6 or 9–8 can be added, which Dandrieu also demonstrates in his treatise ([1718](#), XIII). Accidentals always indicate a new key (or “octave”): “The sharp is a leading tone that announces the key a semitone above” (9).⁽⁸⁾ Thus, every sharp can be understood as a leading tone indicating a modulation to a new key. In this regard, the RoO is an analytical tool for key orientation: “The rule of octaves is no less of consequence for those who sing than for those who play instruments alone; because knowing in which octave they enter, they are prepared, the sharp [leading tone] carrying the same consequence to the melodic as well as to the bass notes” (8).⁽⁹⁾

[1.10] The “big issue” is always to know which key we are in “when we change the octave [i.e., the key]” ([Campion 1716](#), 8).⁽¹⁰⁾ The key is identified by means of functional chords whose characteristic sound makes it possible to assign them immediately to a particular degree. For Campion, there is always a characteristic interval for each degree. For instance, “the tritone is made only on the fourth degree of the key” (11).⁽¹¹⁾ However, the $\frac{6}{4}$ chord with a tritone on the fourth degree can be substituted by a $\frac{6}{\flat 3}$ chord in minor, which is considered an *élégance*: “It is here accompanied by the sixth and the minor third, usually it is accompanied by the sixth and the second, and it is an elegance to accompany it with the minor third, the Composer is obliged to figure it together with the tritone; for the tritone being alone, is accompanied by the second and sixth” (11).⁽¹²⁾

[1.11] This alludes to a notion of chord that differs from nineteenth-century understanding: for Campion it is not the fundamental note (a root) but a major interval in relation to the bass representing the function of the chord. For instance, the tritone is the principal interval of the chord on the descending fourth degree. Normally, the tritone will become a chord through the addition of a second and a sixth, but the version with the minor third instead of the second makes an elegant variation. Despite this difference from a modern view

of harmony, it is possible to convert Campion's understanding of chords into Roman numerals. In seeking to translate Campion's RoO into such nineteenth-century terms, one must be mindful of the following aspects:

- Every accidental, except the major sixth on the descending sixth degree, changes the key in major modes. In minor modes the melodic-minor scale provides the bass degrees, which adds to the harmonic variety of the minor mode.
- The chords have to be understood as simple counterpoint: every suspension is a variation of the chord.
- Every chord has a "nuclear" interval, and the chord can be varied. However, the RoO shows the "normal" state.
- While the RoO informs about an "average" repertoire of chords, there are some "extraordinary" chords in the minor mode. In terms of extraordinary chords, suspensions can also be considered chords.

[1.12] While the RoO's importance for music education in the eighteenth and nineteenth centuries is undisputed, there are divergent assessments and interpretations: is the RoO primarily a model for scale harmonization, is it one among many voice-leading schemata, or is it an early and bass-related theory of tonality? Some authors tend to emphasize the bass's stepwise progression and the RoO's scalar segments for both composition and improvisation. As Giorgio Sanguinetti observes (2012, 114–15), "one of the great advantages of the RO is that it can be used even for short segments, provided one is able to locate them correctly within the appropriate scale." Similarly, Christoph Neidhöfer and Peter Schubert (2023, 90) point out in the recent edition of *Baroque Counterpoint* that "most of the time, composers use only fragments of the rule of the octave."⁽¹³⁾ Other authors, in contrast, tend to subscribe to an understanding of the RoO as a chord repertoire that may be seen as the foundation for a theory of tonality. As stated by Thomas Christensen (1992, 91), "the idea behind the *règle* [. . .] is that each scale-degree can be associated with a unique harmony, one which reciprocally defines that scale-degree." For Ludwig Holtmeier (2009), the RoO even implies a concept of tonality ("Tonalitätsbegriff").

[1.13] Indeed, there are some historical sources that cast doubt on the reductive interpretation of the RoO as a scale harmonization, emphasizing instead the mere position of the chords at specific degrees within the scale. One early anonymous (Italian) source (first erroneously attributed to Alessandro Stradella but probably dating from around 1700) demonstrates the RoO and directly afterwards turns to the application of the given chords on a bass featuring many leaps and almost no segments involving steps (Example 2).⁽¹⁴⁾

The method of applying the chords in their proper position, learned from the RoO, can also be found in later sources, for instance in Giovanni Furno's *Metodo facile breve e chiara ed essenziali regole per accompagnare Partimenti senza numeri* (1817). Sources like this suggest that the RoO can also be understood as a bass-related *Stufentheorie* of tonality (following Christensen and Holtmeier), invariably providing the chords representing the clearest relation to a certain key. In these sources (e.g., Masson 1699 and Dandrieu 1718), we see also a hierarchical arrangement of scale-degrees. Applying this *Stufentheorie* to bass degrees, we can distinguish between two types of the latter, which are related to the use of consonant and dissonant chords:

- Stable degrees with consonant chords, which are particularly suited for leaps in the bass, correspond to the *notes essentielles*, such as degrees $\hat{1}$, $\hat{3}$, and $\hat{5}$ (*finale*, *mediante*, and *dominante*).
- Unstable (or soft) degrees with dissonant chords, more appropriate for stepwise motion in the bass, tend to resolve into the stable chords by stepwise motion (such as degrees $\hat{2}$, $\hat{4}$, and $\hat{6}$ descending, and $\hat{7}$ ascending). They are named in relation to the *notes essentielles* in French theory: *sufinale* ($\hat{2}$), *soudominante* ($\hat{4}$), *sudominante* ($\hat{6}$) and *soufinale* ($\hat{7}$).

[1.14] This French approach to the RoO, then, treats each scale-degree as expressing some abstract role within a key, with the particular harmonizations in the RoO acting as paradigmatic expressions of those roles. This view is further corroborated by the fact that chromatic alterations, or dissonant suspensions and other added chords are not prevalent in the RoO (Heinichen 1728, 907–9). In addition, Campion introduces some ancillary extraordinary—nonprototypical—chords, as noted above.⁽¹⁵⁾ Further examples include:

- the *accord de la quinte superflue* ("augmented mediant chord"; see Moomaw 1985), which is located on the third degree of the minor key: $\text{III} + ^{7(9)}$;
- the *accord de la Neuvième et Septième* ("chord of the 9th and 7th"), located on an ascending fourth degree: $\text{IV}^{7(9)}$ or $\text{iv}^{7(9)}$;
- and the diminished triad, which will be sometimes used on the second degree in minor: ii° .

[1.15] In these formulations, the harmonies expressed in the RoO seem to express something like a standard, quintessential harmony associated with each scale-degree. In such an understanding of the RoO, we would imagine that musical harmonization of particular scale-degrees would not consist exclusively of the chords defined by the RoO—and indeed this is borne out by the historical sources. However, if the harmonies indicated within these RoOs do point to a norm, guideline, or paradigm, we expect those harmonies to be favored in statistical distributions obtained from some corpus. It is important to note, however, that Heinichen has clearly expressed the notion that the validity of the RoO (which he calls *Schema modorum*) is not dependent on a scalar progression in the bass: “For we have [. . .] arranged all our Schemata modorum in such a way that one can invert the bass notes with their overlying signatures as one pleases, and thus go per gradus or per saltus as one pleases” (Heinichen 1728, 904).⁽¹⁶⁾ In his description of the individual degrees Heinichen demonstrates that, for instance, the second degree should have a root-position chord if followed by a leap in the bass (743).⁽¹⁷⁾ Therefore, it is worth examining whether Heinichen’s approach could serve as a useful complement to the RoO as formulated by Campion and Dandrieu, even though Heinichen does not, strictly speaking, belong to the French cultural sphere. The development of major-minor tonal harmony, however, can be considered a cross-border phenomenon in Western music, which is why it makes sense to bring into dialogue different but related theories (irrespective of their alleged national provenance).

1.2. Digital encoding of historical theory: the fifteen RoO chords

[1.16] In order to identify the paradigmatic chords associated with each scale-degree in the French RoO tradition, we can simply use the harmonizations in Campion and Dandrieu, as there is remarkable agreement between them (see Example 1). In order to digitally encode these harmonies, we represented these chords as traditional Roman numerals with inversions, developed by Abbé Vogler and Gottfried Weber in the early nineteenth century. Although such a representation is strictly anachronistic, the RoO’s figures express particular scale-degrees arranged in a particular inversion, the same information contained in a Roman numeral representation. We employed the digital annotation system developed and used by the Digital and Cognitive Musicology Lab (DCML) at EPFL.⁽¹⁸⁾ The resulting fifteen Roman-numeral representations are shown in **Example 3**. In the ensuing analyses, all Roman-numeral designations follow the digital (DCML) annotation standard: figures are listed consecutively rather than stacked, third-inversion seventh chords are noted with only the figure “2,” upper and lower case indicate major and minor, half-diminished quality is shown with a “%,” etc.

[1.17] Taken together, these fourteen distinct chords form the stock repertoire of RoO chords: i, I, V_3^4 , i_3^6 , I_3^6 , $ii_5^{6\%}$, ii_5^6 , V^2 , V , $ii_3^{4\%}$, IV^6 , V_3^4/V , V^6 , V_5^6 , v^6 . There are ten distinct chords in both major and minor, with five chords appearing in both, as shown in **Example 4**. To summarize, we sought to translate a historical understanding of harmony (as evident in the figured bass) into our modern annotation standard, which makes further comparisons with other corpora possible.⁽¹⁹⁾

1.3. Research questions

[1.18] Based on this historical overview, we seek to examine the extent to which the RoO, firstly, covers the most frequently used chords and chord progressions in actual repertoire; and, secondly, specifies scalar segments used by composers of the time in conjunction with the RoO chords. If the RoO is supposed to express the sense of a key unequivocally, we expect the RoO chords to appear considerably more frequently in compositional practice than non-RoO chords. In addition, the RoO places importance (even if only implicitly) on scalar coherence. Therefore, one might expect scalar bass lines to be more frequent than leaping ones. The quantitative analysis of consecutive scale steps versus leaps will help us determine whether the RoO is primarily a theory of stepwise scale harmonization or a theory of which chords to put on individual scale-degrees in isolation. This leads us to the following more specific research questions:

- Q1: How prominent are RoO chords in the entire chordal repertoire used in Couperin’s works?
- Q2: Given a diatonic bass degree, how likely is it to be harmonized by a RoO chord (in comparison to any other non-RoO chord)?
- Q3: How likely is it for any bigram of diatonic bass degrees to support two RoO chords (vs. one RoO chord vs. none)?
- Q4: Given a bigram of diatonic bass degrees connected by leap, how likely is it for that segment to support two RoO chords (vs. one RoO chord vs. none)?

- Q5: Given a bigram of diatonic bass degrees connected by step, how likely is it for that segment to support two RoO chords (vs. one RoO chord vs. none)?
- Q6: Are the bass degrees of the RoO harmonized differently depending on whether consonant chords on stable degrees ($\hat{1}$, $\hat{3}$, $\hat{5}$) or dissonant chords on soft degrees ($\hat{2}$, $\hat{4}$, $\hat{6}$, $\hat{7}$) are involved?
- Q7: The overarching question concerns the extent to which the RoO refers primarily to scalar basses or allows also for leaping basses.
 - Q7a: Is the RoO primarily a unigram model or rather a bigram (or even trigram) model with stepwise bass motion?
 - Q7b: Would Heinichen’s rule for leaps after soft degrees (preferring root-position chords on them) be a useful addition to Campion’s RoO?
 - Q7c: For which combinations of diatonic bass motion (step, leap, . . .) are the 10 RoO chords a better explanatory model than the 10 most frequent chords?

2. The Dataset⁽²⁰⁾

2.1. Historical characterization of the repertoire

[2.1] Historically positioned between the famous opera composers Jean-Baptiste Lully (1632–1687) and Jean-Philippe Rameau (1683–1764), François Couperin (1668–1733) may be considered one of the most prominent composers of the French Baroque, and one of the most important European composers of instrumental music at the beginning of the eighteenth century. As he explains in the preface to the *Troisième livre de pièces de clavecin* (1722), he started composing a series of concerts in the 1710s which were performed first 1714 and 1715 at the Sunday concerts for King Louis XIV. Later he published four of them as *Concerts Royaux* in the *Troisième livre* in 1722, whereas the concerts nos. 5–14 were published as *Les Goûts-réunis ou Nouveau Concerts* together with the *Apothéose de Corelli* in 1724.

[2.2] Couperin’s concerts are written for a melody instrument and figured bass. In spite of today’s use of the term “concert,” they are more closely associated with the sonata than with the Italian concerto. As Couperin’s preface tells us, they can be performed as harpsichord pieces, solo sonatas, or chamber sonatas.⁽²¹⁾ Such a hybrid concept can also be found in compositions by Charles Dieupart (*Six suites de Clavessin*, 1701, also published in 1702 “mises en concert” as solo sonatas) or Gaspard le Roux (*Pieces de Clavecin*, 1705, printed as keyboard pieces as well as trio sonatas). Some pieces include even an optional middle voice (*contre partie*) or suggestions for a performance on the harpsichord alone. All of Couperin’s concerts, except nos. 12 and 13, exhibit a detailed figured bass that conveys a clear sense of the harmony as imagined by the composer. In some cases, Couperin uses abbreviations, such as “6” on the second degree, which stands for the “petite sixte” chord ($\frac{6}{4}$). Apart from such rare cases and the two concerts without figures, Couperin’s concerts can be seen to represent the harmonic practice of French instrumental music from the 1710s and 1720s—the time when the theory of the RoO was established in France. Our corpus therefore contains the four *Concerts Royaux* as well as all the *Concerts Les Goûts-réunis*, with those lacking figures and those using multiple instruments (nos. 12 and 13) being excluded. The *Apothéose de Corelli* as a part of the publication of the *Concerts Les Goûts-réunis* was also included in the corpus.

[2.3] As a contrasting corpus, we selected a repertoire composed by Arcangelo Corelli, and did so for several reasons. First, Corelli was held as an exemplary chamber music composer by contemporary audiences and critics across Europe, with Johann Mattheson recommending him as an “excellent model” for the “chamber style” in 1739 (Mattheson 1739, 91). Additionally, Couperin himself respected and studied Corelli’s music. In the preface to *Les nations* (1726) he declared that he would love the sonatas of the “Signor Corelli [. . .] as long as I live,”⁽²²⁾ and his *Apothéose de Corelli* (1724) is an homage dedicated to Corelli in the same vein as the *Apothéose de Lully* (1725), in which Corelli also appears in a musical guise (Menke 2020c).

2.2. Characterization of the dataset

[2.4] Together, the fourteen concerts and *Le Parnasse ou l’apothéose de Corelli* amount to ninety-one movements, eighty-four of which have been annotated and evaluated in the present study. (We chose to omit concerts nos. 12 and 13, because they lack a continuous figured bass.) The scores represent a digital encoding of the Paris 1722 and 1724 *princeps* editions and have been engraved for this project using MuseScore 3.

Wherever necessary, mild interventions (modernizations) have been applied to guarantee an accurate representation of musical relations. **Example 5** shows an excerpt from the first print, in which the last three measures represent the three possible continuations of the first one, which is measure 15. The first two continuations have been encoded as first and second endings (mm. 16a and 16b, respectively) with the particularity that measure 16b is followed by the *petite reprise*. The markup leaves no doubt to the performer that measure 16b is leading back to two different temporal positions in m. 14. In terms of a faithful digital encoding, however, the optimal way to represent that situation was to unfold the *petite reprise*, resulting in the two additional measures numbered 17 and 18.

[2.5] The MuseScore files are the backbone of the dataset and include both metadata and the expert annotations (see sections 2.3 and 2.4). To facilitate processing and evaluation, each score is accompanied by several tabular files representing one of its facets, which include one containing one row per note and one with all the annotation labels.⁽²³⁾ The table shown in **Example 6** summarizes the dataset’s characteristics in terms of number of movements, measures, notes, and annotation labels for each concert and its average number of movements, as well as the total length given in quarter notes. On average, each concert has six movements with three outliers (in terms of standard deviation), namely Concert no. 12 with three movements, and nos. 3, 8, 9, and 11 with eight to eleven movements, respectively.

[2.6] The Corelli corpus contains his highly influential opp. 1, 3, and 4 (composed in 1681, 1689, and 1694, respectively). This dataset consists of twelve pieces per opus, for a total of 149 movements.⁽²⁴⁾ The movements from the Corelli dataset have been enriched with harmonic and key annotations by the DCML team of annotators, which resulted in 14,314 distinct labels.⁽²⁵⁾

[2.7] For purposes of homogeneity, our analyses separated segments by major and minor mode (following Moss et al. 2019 and Hentschel et al. 2021). All corpus analyses were performed using the DiMCAT (v3.4.0) analysis toolkit (Hentschel et al. 2023).

2.3. The DCML annotation standard

[2.8] The MuseScore files have been manually annotated drawing on the latest version of the DCML harmony annotation standard (Neuwirth et al. 2018; Hentschel et al. 2021; Hentschel et al. 2025). The standard consists of a set of analytical guidelines, a vocabulary, and a syntax that allows annotators to exhaustively encode their analysis of global and local keys, cadences, phrase segments, and tonal harmony.

[2.9] The DCML harmony annotation standard used here allows us to account for a high degree of structural detail in the music, involving both the level of key and the level of the individual chords. Keys occurring within a movement (“local keys”) are referenced by means of Roman numerals in relation to the main key. Fleeting references to a key are denoted with the help of “applied chords.” With regard to the level of chords, the standard allows to encode the features of “chord type,” “chord form,” “suspensions,” “added/missing notes,” and harmonic motion over a pedal (for more details, see Hentschel et al. 2021 and Hentschel et al. 2025). The various features encoded in the labels are given in separate columns of the tabular files included in the dataset, from where they can easily be transformed into other representations. For instance, the “chord form” determines the inversion of a Roman numeral label, and hence the bass note which can be expressed as a scale-degree.

2.4. Historically informed annotation and annotation procedure

[2.10] In our annotation procedure, we relied on established historical knowledge regarding the realization of figured bass in French music and a historically informed understanding of chord/harmony, guided primarily by the figured bass. In particular, knowledge of French thoroughbass enables us to read a figure such as “6” to stand for “ $\frac{6}{4}$ ” whenever it appears on scale-degree $\hat{2}$ (the *petite sixte*, as mentioned above).⁽²⁶⁾ Sometimes, in such a case, the melody includes a fourth when only a “6” appears in the figured bass, indicating a $\frac{6}{4}$ chord (see **Example 7**). Of course, we cannot be certain that every French continuo player has played every *petite sixte* chord with a fourth, but it is safe to assume that every second degree could potentially carry a $\frac{6}{4}$ chord.

[2.11] One unique chord deserves special attention: the *quinte superflue*, for which we used III+. Rather than interpreting this harmony as a suspension over a i^6 chord, we provide this harmony its own annotation, as the

sonority was treated as a chord of its own quality in French music theory (Moomaw 1985). Dissonances produced by mere ornaments (*agréments*) were not annotated, and were instead considered fleeting surface structures rather than part of the harmonic structure (as reflected in the figured bass).

[2.12] Using the DCML standard, the roughly 8,750 labels were created by Eva-Maria Hamberger, Tobias Drewelius, and Johannes Menke. Thereafter, the annotations have undergone several iterations of updates and reviews. Notably, Hanné Becker enhanced the dataset with cadence labels, which had not been included by the original annotators, and also proofread those harmonic labels that had been marked as dubious with respect to the score content by a verification algorithm. Johannes Menke (first author) reviewed the current version of the dataset once more in its entirety for this publication.⁽²⁷⁾

3. The Règle des octaves from an Empirical Perspective: Methods and Results

3.1. Statistical coverage

[3.1] In our study, we treat chord sequences as strings with n consecutive elements, which allows us to employ n -gram analysis (with variable window size) as a standard method of corpus research. This approach aims to reveal the frequency distribution of chords (unigram) and the preferred transitions between them (bigrams and trigrams), distinguishing between major- and minor-mode segments.

3.2. Chord frequencies in the Couperin corpus

[3.2] The Couperin corpus contains 84 annotated movements with 566 local-key segments and 739 musical phrases. There are 4,138 chords (tokens) within the major mode-segments using 120 distinct chord types. Minor-mode segments make use of 4,238 chords, which derive from 169 chord types (see **Example 8**). As is typical, the frequency of chord types approximately follows a Zipf distribution:⁽²⁸⁾ In the major mode, for example, the first five ranks alone (I, V, I⁶, V₅⁶, and V⁷) suffice to cover more than half (57.92%) of the entire distribution; the first ten ranks cover nearly 75%.

[3.3] In order to address our Q1 (see section 1.3), we examine the general use of the chordal repertoire in Couperin’s works, specifically focusing on the frequency of the RoO chords. As shown in **Example 8**, 67.2% and 62.7% of observed chords in major- and minor-mode excerpts are chord paradigms from the RoO, respectively. Taken together, 64.6% of all observed chords are those described by the RoO. More specifically, the *finale* (I), *dominante* (V), and *mediante* (I⁶) as chords on the *notes essentielles* account for 46.8% of all observed chords in the major-mode corpus and 40.5% in the minor-mode corpus. In major, seven of the ten most frequent chords are RoO chords, versus 8 in minor. All but one RoO chord (IV⁶ in minor) are within the top 20 chords, making up half of the ranks in major. Several chords *not* part of the RoO play a prominent role in Couperin’s style, such as V⁷ (V with an additional seventh), (root-position) IV, and vi. Chords such as ii⁶, V₄⁶, and I₄⁶, characteristic of the classical style (Hentschel et al. 2021), all appear among the top 20 but are already below the 1% threshold in the Couperin corpus, which shows a preference for ii₅⁶ and V⁽⁴⁾ instead, in keeping with the Baroque idiom. Further non-RoO chords appearing among the top 20 in Couperin’s works are ii, ii⁷, and vi⁷.

[3.4] Some chords characteristic of the French style in general, or of Couperin’s idiom in particular, appear less often than one might perhaps expect: for instance, the *accord de la quinte superflue*, III+⁷⁽⁹⁾, is ranked 38th (in minor, 0.31%); in comparison, the sixth chord of the augmented chord, III+⁶, was used more frequently (ranked 26th, 0.61%). The “Couperin chord” IV^{M7(9)} (Dubruque 2020) is ranked 34th in major; in minor, we can find two versions: iv⁷⁽⁹⁾, ranked 36th, and IV⁷⁽⁹⁾, ranked 49th. One might argue that the rarity of these characteristic chords does not undermine their status as fingerprints of the French Baroque style; instead, they emerge as salient features within the broader harmonic repertoire, whose distinctive sonic qualities remain perceptible regardless of their relative frequency.

[3.5] Corelli’s corpus exhibits several similarities with Couperin’s (**Example 9**). The chords on the *notes essentielles* (I, V, and I⁶) form the top 3 of the major mode’s frequency distribution in both corpora. The 5th rank (V⁷) is also identical in both. However, Corelli’s corpus exhibits a very different relationship with the RoO’s harmonic paradigms. Whereas in the Couperin corpus, the RoO chords clearly outnumber the non-

RoO chords, in the Corelli corpus, only 49.3% (major) and 45.5% (minor) of the chords are accounted for by the RoO. There are several further differences between these two corpora:

- IV is slightly more frequent in Corelli's works than in Couperin's.
- V_5^6 , ranked 4th in the Couperin corpus, ranks 21st in Corelli's; this may be due to Corelli's much more frequent use of V^6 (ranked 7th) as an alternative, which does not contain the diminished-fifth dissonance.
- The frequent use of V_3^4 (ranked 8th) in the Couperin corpus cannot be found with Corelli, either; there, it is ranked 66th. One may hypothesize that Corelli uses vii^{o6} (ranked 14th) instead as a functionally equivalent sonority.
- In both corpora, the $V^{(4)}$ is the most frequent suspension, although they differ with the respective ranking: 8th with Corelli and 14th with Couperin. This slight difference is sort of compensated in the Couperin corpus by the much more frequent use of $V_4^{(6)}$ as the second-most-employed suspension chord (ranked 17th), which plays a lesser role with Corelli (ranked 24th).
- Further differences concern the reversed preference for chords of ii^6 and ii_5^6 , the former being more frequent with Corelli, and the latter being slightly more preferred by Couperin (again corroborating the French composer's preference for denser sonorities).

[3.6] With respect to the minor mode, the following observations can be made:

- The first three ranks are covered by i , V , and i^6 in both Couperin's and Corelli's works (40.47% of all tokens with Couperin).
- All forms of V chords are used in Couperin's works. Apart from root-position V (ranked 2nd), this concerns V_5^6 (4th), V^7 (6th), V_3^4 (7th), and V^2 (10th). The V^2 chord, in particular, is more important in the minor-mode context than it is in major. In comparison, the V_5^6 , V_3^4 , and V^2 chords play a much smaller role with Corelli. This may reflect the fact that the French version of the RoO also includes inversions of the dominant-seventh chord.
- As in the major mode, $V^{(4)}$ is the most frequent suspension in both corpora. However, there are striking differences between the two styles. While in Couperin's works, $V^{(4)}$ remains the only frequent suspension in minor-mode contexts, in Corelli's works, $iv_{(2)}^6$ and $i^{(9)}$ are the second- and third-most commonly used suspensions, even ranking higher than $V_4^{(6)}$. That is, with Corelli, there seems to be a somewhat stronger tendency toward the use of suspensions in minor-mode contexts.
- Both corpora have in common that ii_5^{o6} is the most frequent appearance of ii , which in Corelli's works is more frequent than ii^{o6} . It is these two chords, in addition to V^2 , and rather than iv , that are used to harmonize scale-degree $\hat{4}$. Furthermore, Couperin tends to borrow chords from the parallel major, such as I and IV (both in root position), which is much rarer with Corelli. The IV^6 , as part of the ascending upper tetrachord of the RoO, is ranked 31st and hence is the most infrequent RoO chord.

3.3. Chords in relation to bass degrees and motions

[3.7] While the previous section examined the distribution of chords within each corpus and its relationship to the RoO, this section investigates how those harmonies relate to bass notes and how those bass notes chain together to create chord sequences. To the former, we will ask Q2 (see 1.3): Given a diatonic bass degree, how likely is it to be harmonized by a RoO chord (in comparison to any other non-RoO chord)? If all chords are taken in account, the probability of any RoO chord over a diatonic bass degree is 65.7% (plus 3.3% for a RoO suspension chord). This finding reflects the generally high quantitative coverage of the entire chord distribution by RoO sonorities.

[3.8] The tables in **Examples 10 and 11** add more granularity to this overall observation. The RoO makes its most accurate predictions with regard to the chords to expect over scale-degrees $\hat{1}$, $\hat{3}$, $\hat{5}$, and $\hat{7}$. In the major mode, scale-degrees $\hat{5}$ and $\hat{1}$ (two of the *notes essentielles*) are the most frequently used in the bass, each accounting for approximately 25% of the distribution. Scale-degree $\hat{5}$ is harmonized with the V chord—a RoO paradigm—60% of the time. Over scale-degree $\hat{1}$, the root-position tonic chord—another RoO sonority—outnumbers other (non-RoO) chords by far, covering 89.4% of the distribution. Scale-degree $\hat{3}$, the third of the *notes essentielles*, accounts for 11.6% of all bass notes, and the RoO chord I^6 is by far the most prominent choice in the Couperin corpus, explaining 86% of the distribution.

[3.9] In terms of the “soft degrees,” $\hat{7}$ is almost invariably harmonized by RoO chords, either V_5^6 (62.6%) or V^6 (31.5%). Weaker predictions are made with respect to the remaining soft degrees: With regard to scale-degree $\hat{4}$, there are two RoO chords that appear among the top-5 chord types, ii_5^6 (32%) and V_2^4 (16%), with

the most frequent chord being root-position IV. Scale-degree $\hat{6}$ (8.1%) typically carries two RoO chords: IV^6 (24.9%) and V_3^4/V (9.6%), which in total cover one third of the entire distribution. And finally, with regard to scale-degree $\hat{2}$, the RoO chord V_3^4 is the most prominent choice (39.5%), followed by ii as a non-RoO chord (27%).

[3.10] Example 10's table shows also very clearly that in major modes there are root-position chords used on the soft degrees, which are not predicted by the RoO. Of these, 36.5% appear on the sixth degree, 34.3% on the fourth degree, and 27.7% on the second degree.

[3.11] Another important question for our research endeavor concerns the issue of how RoO chords are approached and departed in the bass (see again Examples 10 and 11). To study these sequences, we tracked how often each chord is approached by step versus by leap. In this context, we want to draw attention to a few aspects that describe how Couperin deals with the RoO chords. In particular, we focus on three dissonant chords on soft degrees, the three inversions of the dominant seventh chord: the *accord du triton* (V^2 on the fourth degree), the *accord de la petite sixte* (V_3^4 on the second degree), and the *accord de la fausse quinte* (V_5^6 on the seventh degree), comparing the major and minor modes.

[3.12] Our analysis reveals that only 15.8% (major) and 15.5% (minor) of all fourth degrees carry the *accord du triton*. In major modes, the IV triad is the most frequent chord (34.3%), whereas in minor, this role is fulfilled by $ii^{\frac{6}{5}}$ (36.6%). It may be surprising that the *accord du triton*, which has, in contrapuntal terms, its dissonance in the bass (to be prepared and resolved), is approached by leap in 22.8% (major) and 13.3% (minor) of cases. Even the resolution is sometimes accomplished by leap: 10.1% (major) and 8.2% (minor). In contrast to other chords—which resolve invariably by step and are reached more correctly, that is to say by a repeated bass note or by step. This shows that the *accord du triton* is treated with certain flexibility.

[3.13] The *accord de la petite sixte* (V_3^4), based on the second degree, shows a similarly flexible treatment: around 20% (both major and minor) are both approached and left by leap. Finally, we find a similar and even more flexible use of the *accord de la fausse quinte* (V_5^6 on the seventh degree). This is the most prominent chord on the seventh degree in both major and minor, and it is approached and left by leap about 30% of the time. In minor modes, it is approached by leap in 52.9% of the time. This result actually tells us something about the tonal idiom of the time: in minor keys, it seems to be quite typical to reach the *accord de la fausse quinte* by leap.

3.4. Chord Transitions 1: Frequency of Bigrams in Couperin

[3.14] In what follows, we focus on the relationship between bass line and chordal sonority in a more general sense. In particular, we move on to tackle our Q3 to Q5, starting by scrutinizing the probability for any bigram of diatonic bass degrees to support two RoO chords (vs. one RoO chord vs. none; Q3). The analysis reveals that in only 14.6% of cases is no RoO chord involved at all. More likely, at least one of the two chords (whether the antecedent or the consequent chord) stems from the RoO (34.3%, plus 1.2% when including suspensions). However, the most likely case is that both chords derive from the RoO (44.1%, plus 5.7% when including suspensions).

[3.15] This initial research question can now be specified according to whether or not the two diatonic bass degrees are adjacent in the scale, as we wish to tackle the overarching question of whether the RoO is primarily a schema for harmonizing a scale or a theory defining a key's chord repertoire. Focusing first on the scenario of leaping bass notes, the question is the following (Q4): Given a diatonic segment of two non-stepwise bass notes, how likely is it for that note pair to support two RoO chords (vs. one RoO chord vs. none)? Interestingly, the outcome strongly resembles the finding just reported for any bigram of bass degrees: While 13.4% of all note pairs considered do not support any RoO chord, 37% (+0.3%) carry at least one RoO chord, and in 46.1% (+3.1%), both chords stem from the RoO.

[3.16] The outcome changes more significantly when looking at linear bass notes. The corresponding question is as follows (Q5): Given a diatonic segment of two (diatonic) bass notes connected by step, how likely is it for that segment to support two RoO chords (vs. one RoO chord vs. none)? While the probability for no RoO at all drops further in comparison to the earlier scenarios (10.1%), the probability of just one RoO chord also decreases (25.0%; +1.2%). By contrast, the probability of both chords deriving from the RoO increases significantly (59.2%; +4.5%). This finding may be interpreted as evidence in favor of the importance of the RoO as a model for scale harmonization, though this does not deny its general function as a model of tonality.

[3.17] Next we move on to tackle our Q6: Are the bass degrees of the RoO treated differently depending on whether they are consonant chords on stable degrees ($\hat{1}$, $\hat{3}$, $\hat{5}$) or dissonant chords on soft degrees ($\hat{2}$, $\hat{4}$, $\hat{6}$, $\hat{7}$)? As a first approach to that question, we shall concentrate on the bigram behavior of the RoO chords. Most likely, I as a chord based on one of the *notes essentielles* moves by a leaping bass to V (167, or 23.7%) or I^6 (74, or 10.5%), rather than by a step up to V_3^4 (22, or 3.1%) or down to V_5^6 (46, or 6.5%) or V^6 (46, or 6.5%), as is suggested by a solely scalar understanding of the RoO. The next RoO chord, V_3^4 , which is based on one of the soft degrees, shows a strong tendency to move downwards by step either to I (84, or 27.7%) or i (85, or 28.1%) rather than ascending, again by step, to I^6 (25, or 8.3%) or i^6 (45, or 14.9%). Less likely are examples of moving between chord inversions (*renversement*, according to Rameau), here from V_3^4 to V_5^6 (32, or 10.6%), similar to what we have seen with the tonic chord. The RoO chord on the *note essentielle* scale-degree $\hat{3}$, I^6 , moves more likely by leap to I (86, or 20.8%) than by descending step to V_3^4 (62, or 15.0%) or ascending step to ii_5^6 (64, or 15.5%). The behavior of the ii_5^6 chord, which is based on the soft degree of $\hat{4}$, is again in full accordance with a scalar understanding of the RoO in that it most likely moves by step up to V (89, or 50.9%), possibly to achieve a cadence.

[3.18] Within the scale's upper tetrachord, the most likely destination of the *note essentielle* chord V is I (256, or 22.8%) or i (196, or 17.4%), corresponding to a leaping $\hat{5}-\hat{1}$ bass clausula in the bass. A stepwise ascent in the bass to IV^6 (16, or 1.4%), as shown by the RoO, is rare. By contrast, IV^6 , as a chord on the soft degree $\hat{6}$, has a strong inclination to proceed by a stepwise bass ascent, producing a move to V_5^6 . And V_5^6 , as yet another chord on a soft degree, moves up by step to I (153, or 32.8%) or i (123, or 26.3%) in the vast majority of examples, with the next-most common move being to its root position V^7 (111, or 23.8%).

[3.19] Two characteristic chords of the descending variant of the RoO, V_3^4/V and V^2 , show clear tendencies toward resolution and stepwise bass motion: V_3^4/V , based on the soft degree $\hat{6}$, has a strong propensity to resolve downward by step to V (31, or 88.6%), while V^2 , based on the soft degree $\hat{4}$, shows a high probability of resolving downward by step to either I^6 (678, or 38.1%) or i^6 (83, or 47.2%). The picture emerging from the analysis of chord transitions on the bigram level suggests a more nuanced picture of the RoO: while a scalar understanding is largely valid for the dissonant chords on the soft degrees, such as V_3^4 , V^2 , and V_3^4/V (downward) and ii_5^6 , IV^6 , and V_5^6 (upward), there is a more flexible use of (consonant) chords of I, I^6 , and V (based on the *notes essentielles*), which are more often moving by leap.

3.5. Chord Transitions 2: Frequency of Bigrams in Couperin Compared with Corelli

[3.20] In Corelli's works, there are eight bigrams within the top 20 (major mode) that are harmonizations of scalar excerpts (see **Example 12**). Yet they differ from the progressions found in the Couperin corpus. While scale-degree progressions $\hat{3}-\hat{4}$ ($I^6 \rightarrow IV$ and $I^6 \rightarrow ii_5^6$) and $\hat{4}-\hat{5}$ ($ii_5^6 \rightarrow V$; $IV \rightarrow V^7$; and $ii^6 \rightarrow V$) are covered harmonically more than once, neither $\hat{1}-\hat{2}$, $\hat{2}-\hat{3}$, $\hat{5}-\hat{6}$, nor $\hat{6}-\hat{7}$ appear within the top 20.

[3.21] Turning to the minor mode, the transitions between any two chords happen frequently between those chords that rank high in the unigram distributions as well. In Couperin's works, there are large numbers of $V \rightarrow i$ (ranked 1st) and $i \rightarrow V$ progressions (2nd); the most frequent RoO progressions with adjacent bass notes are $V_5^6 \rightarrow i$ (4th), $ii_5^6 \rightarrow V$ (6th), $V_3^4 \rightarrow I$ (7th), $V^2 \rightarrow i^6$ (8th), and $i^6 \rightarrow V_3^4$ (9th). Slightly less frequent, but still among the top 20, are RoO progressions such as $i^6 \rightarrow ii_5^6$, $i \rightarrow V_5^6$, and $V_3^4 \rightarrow i^6$. What is particularly striking is that in Couperin's works the root-position iv chord, despite its frequent occurrence in the unigram distribution (rank 9), does not appear in any of the top-20 bigram progressions. This suggests that the iv chord is involved in multiple bigrams and hence does not allow us to reliably predict the subsequent chord event.

[3.22] By comparison, in Corelli's works $V^6 \rightarrow i$ (ranked 4th) and its reverse $i \rightarrow V^6$ (8th) are much more frequent than in Couperin, reflecting the Italian composer's preference for V^6 rather than V_5^6 to harmonize scale-degree $\hat{7}$ in the bass. Like Couperin, Corelli is most likely to harmonize a bass ascent from $\hat{4}$ to $\hat{5}$ as $ii_5^6 \rightarrow V$ (ranked 10th), while the bass ascent $\hat{3}-\hat{4}$ is most likely covered by $i^6 \rightarrow ii_5^6$ (ranked 14th, and hence very similar to Couperin).

[3.23] Unlike Couperin, who uses bass motion from $\hat{2}$ to $\hat{3}$ to harmonize $V_3^4 \rightarrow i^6$ (ascending, ranked 18th) or $i^6 \rightarrow V_3^4$ (descending, ranked 9th), Corelli uses this scalar excerpt less frequently, as it does not appear within the top 20. Instead, the descending linear motion from $\hat{6}-\hat{5}$ in the bass plays a much more important role for

Corelli, where it is harmonized by the Phrygian progression $iv^6 \rightarrow V$ (ranked 6th). Couperin tends to harmonize the descending $\hat{6} \rightarrow \hat{5}$ motion differently, using $ii^{\%4}_3 \rightarrow V$ (ranked 21st). Generally, Corelli shows a penchant for using the iv chord much more consistently in combination with two specific chords, the i^6 chord ($i^6 \rightarrow iv$, ranked 16th) or the V chord ($iv \rightarrow V$, ranked 17th).

[3.24] Corelli tends to prepare $V^{(4)}$ with either a root-position tonic (ranked 9th) or a iv^7 chord (22nd). Despite being the most frequent suspension in Couperin (ranked 15th), $V^{(4)}$ does not appear within any of the top-20 chord pairs, implying a more varied use regarding the preparation and resolution of that chord. To summarize: Although Corelli was a model for Couperin, his harmonic style differs in many details.

3.6. Chord Transitions 3: Frequency of Trigrams in Couperin

[3.25] Extending the window still further into trigrams (Q7a), there are only six progressions among the top 25 that show a linear bass motion. Chief among them are those that ascend or descend within the lower tetrachordal half of the scale, such as $i^6 \rightarrow ii^6_5 \rightarrow V$ (29, or 5.39%), $I^6 \rightarrow ii^6_5 \rightarrow V$ (17, or 3.16%), $I^6 \rightarrow V^4_3 \rightarrow I$ (25, or 4.65%), or $i^6 \rightarrow V^4_3 \rightarrow i$ (19, or 3.53%). The upper half of the scale is covered only partially, by $IV^6 \rightarrow V^6_5 \rightarrow I$ (16, or 2.97%) or $i \rightarrow V^6_5 \rightarrow i$ (13, or 2.42%). Other typical RoO progressions such as $V^4_3 \rightarrow I^6 \rightarrow ii^6_5$ or $V \rightarrow IV^6 \rightarrow V^6_5$ do not appear among the top 25. To summarize, our analysis suggests that harmonizations of a linear bass involving three adjacent RoO sonorities are comparatively rare in the repertoire considered (Q7).

3.7. Motion types

[3.26] In this section, we take a closer look specifically at the types of motion between consecutive bass notes supporting a harmonic progression. Here we categorize intervals between any pair of consecutive bass notes if they appear in the same key. The distributions of intervals over all bass bigrams in a single major or minor key are shown in **Example 13**. Since each bass note is given as a scale-degree, the intervals are specific, e.g., “minor third” or “m3,” rather than just a number of semitones. We group them into the following six categories:

- **Same:** This is defined as a perfect unison (P1).
- **Diatonic step:** An ascending or descending motion within the RoO. In minor, this includes, for instance, $\hat{5} \rightarrow \sharp\hat{6}$ and $\hat{6} \rightarrow \hat{5}$, but not $\hat{5} \rightarrow \hat{6}$ or $\sharp\hat{6} \rightarrow \hat{5}$ (see section 1.1).
- **Other step:** A stepwise or chromatic bass progression not included in the RoO. This includes, for example, $\sharp\hat{4} \rightarrow \hat{5}$ or, in minor, $\hat{5} \rightarrow \hat{6}$.
- **Diatonic leap:** A leap (interval larger than a second) between two bass notes within the RoO.
- **Other leap:** A leap between two bass notes, at least one of which is not part of the RoO (e.g., between $\hat{6}$ and $\sharp\hat{4}$).
- **None:** motion type when a bass note has no successor in the same key.

The result of this categorization of intervals is shown in **Example 14**, where “Same” values correspond to “P1” values in Example 13; the remaining categories are aggregations of interval values. The category “None,” which covers all bass notes at the end of a key segment, has no correspondence in Example 13.

[3.27] We can extend the exploration of motion types to summarize not only motion from any bass degree to the following one, but also the motion from the preceding bass degree. This is visualized in the Sankey diagrams in **Examples 15 and 16**, which are to be read from left to right: the vertically stacked nodes on the left represent motion leading into a given harmony (stacked in the middle), and the stacked nodes on the right refer to the motion leading out of it. In Example 15, the bass degrees are represented by three stacked nodes in the middle, categorizing them into bass notes that are included in the RoO *and* carry the corresponding RoO chord (“RoO chord”), RoO bass notes that carry a variant chord with suspensions (“RoO suspension”), and “Other” chords. The height of stacked nodes is proportional to the corresponding frequencies, as are the heights of the bands connecting them. For example, the light-green middle node “RoO chord” represents all 5,413 chords corresponding to an RoO harmony. The incoming bands on the left represent the proportion of bass motion types preceding these chords, revealing that ~2,546 (47.0%) are being reached by diatonic leap, ~1,909 (35.3%) by diatonic step, and ~958 (17.7%) are reached by some other motion or have no preceding harmony in the same key. The outgoing bands on the node’s right show the analogous distribution over the subsequent bass motion types. One can also begin with the pink “Diatonic leap” node on the top left, which

represents the 3,809 chords that are reached by diatonic leap; this node’s outgoing bands show that 1,155 (30.3%) leaps land on non-RoO chords (“Other”), and 116 (3.0%) land on RoO chords with suspensions.

[3.28] Examples 15 and 16 help to answer Q7a: Does the RoO refer primarily to scalar basses, or is it a theory of individual scale-degrees (hence also including leaping basses)? Because the question concerns both major and minor, they are summarized here in one diagram. As Example 15 clearly shows, RoO chords are more often reached and left by diatonic leap in the bass (red) than by step (blue).

[3.29] Also, we arrive at a more nuanced answer with regard to Q6, as we can see in Example 16: the *notes essentielles* (degrees $\hat{1}$, $\hat{3}$, and $\hat{5}$) are reached and left by leap (red) much more frequently than the soft degrees are ($\hat{2}$, $\hat{4}$, $\hat{6}$, and $\hat{7}$), the latter of which display a more frequent use of stepwise motion in the bass, especially when departing from the RoO chord. In particular, the probability of a RoO chord occurring after a *note essentielle* is almost equal whether the bass moves by leap or by step (73% or 71%, respectively). The difference between stable and soft degrees becomes more evident when considering the way the soft degrees are used: the probability of a RoO chord drops to 50% when the preceding soft degree moves by leap, but increases to 80.5% when a soft degree moves by step. The reason seems to be obvious: chords on the *notes essentielles* are mostly consonant and can move freely (by leap or step), whereas chords on the soft degrees are often dissonant and must resolve stepwise in the bass.

[3.30] When summarizing the findings from section 3 so far, a contradictory picture emerges. On the one hand, RoO chords are reached and left more frequently by leap than by step (Example 15). On the other hand, however, stepwise bass motion can be better explained with the RoO than those with leaps (Example 16). We propose to resolve this contradiction by emphasizing the distinction between *notes essentielles* in the bass, which may carry root-position chords, and which can move by leap or step, and the remaining soft degrees, whose progressions are more constrained (by step) and contain dissonance resolutions. In addition, Heinichen’s rule to use root-position chords on the second, fourth, or sixth degrees when the bass leaps is a useful addition to the RoO (see our Q7b).

3.8. Comparison with top-k vocabularies

[3.31] In this final section, we seek to answer Q7c by evaluating the RoO’s explanatory power under various scenarios constructed from four of the six types of bass motion introduced in the previous section (leaving out those involving non-diatonic neighbor notes). We do so by comparing the RoO with a baseline model constructed from the ten most frequent chords. Specifically, we treat the RoO as two unordered chord vocabularies $\mathcal{V}_{RoO}$ of 10 chords each, $\mathcal{V}_{RoO}^+$ for major and $\mathcal{V}_{RoO}^-$ for minor, and compare each of them with the vocabulary constructed from the ten most frequent chords, $\mathcal{V}_{top-10}^+$ and $\mathcal{V}_{top-10}^-$ respectively. For any given scenario—say, one where all bass notes are both reached and left in diatonically descending stepwise motion—we construct the corresponding subset $\mathcal{S}$ from all 8,376 chord occurrences in the Couperin corpus, treat it as an urn model, and interpret the conditional probability to draw a $\mathcal{V}$ -chord from $\mathcal{S}$:

$$\mathcal{P}(\text{draw} \in \mathcal{V} \mid \text{urn} = \mathcal{S})$$

The rationale is simple: if some vocabulary $\mathcal{V} \neq \mathcal{V}_{top-k}$ with $|\mathcal{V}| = k$ (read: any vocabulary $\mathcal{V}$ that has size k and is different from the k most frequent chords in the corpus) explains a given subset better than the baseline $\mathcal{V}_{top-k}$, then we view it as the better music-theoretical model for that subset. The question we ask is under which scenarios $\mathcal{V}_{RoO}$ performs better than the baseline.⁽²⁹⁾

[3.32] **Example 17** exhibits the results of this comparison for all nineteen subsets, for major and minor respectively. For example, the row for subset $\mathcal{S}_{all}$ shows that the probability to randomly draw a RoO chord from all major unigrams is 67.2%, the one for all minor unigrams is 62.7% (identical to the probabilities reported in section 3.2). We conclude that, as a statistical model, the RoO performs 7.9 and 5.8 percentage points worse than the respective *top-10* models. In the following, we will elaborate on the conclusions we draw from the remainder of this table.

[3.33] The unigram subset for which the RoO’s outperforms the *top-10* vocabulary $\mathcal{V}_{top-10}$ the most (both in major and minor) is shown on the first row of Example 17, called “to_and_from_descending.” The name corresponds to the subset of all 490 unigrams that are reached and left by descending diatonic motion (i.e., that

appear in the middle of a descending scalar segment of size 3): $\mathcal{V}_{RoO}^+$ covers 85.7% and $\mathcal{V}_{RoO}^-$ 74.5%—roughly twenty percentage points better than $\mathcal{V}_{top-10}$ (63.2% and 55.2% respectively). For unigrams from major segments, this is also the subset for which the RoO performs best, accounting for 85.7% of this scenario, closely followed by “to_and_from_either” (unigrams for which the preceding and subsequent bass notes are the upper or lower diatonic neighbor), and “to_and_from_ascending,” which is the subset for which $\mathcal{V}_{RoO}^+$ performs best (81.1%). The remaining subsets for which RoO has better explanatory power than the ten most frequent chords are larger subsets that comprise unigrams either followed by a diatonic neighbor (“to_ascending,” “to_descending,” “to_either”) or preceded by one (“from_ascending,” “from_descending,” “from_either”), irrespective in both cases of the other side. Vice versa, the RoO performs worse on all other subsets which include first and last unigrams in a key segment (subset “None”) and all combinations of “leap” and “same” on either side of the unigram. Notably, for the latter, the RoO performs particularly poorly, with explanatory powers under 50%. We take this neat separation between (a) subsets that the RoO explains better and (b) those that it explains worse than the 10 most frequent chords as further evidence that the RoO is a model particularly well suited for explaining how adjacent scale-degrees (diatonic neighbors) are harmonized in direct succession, but that it is not a model for explaining all other types of bass progressions. In addition, from a generative and didactic perspective, we can interpret the results of this more fine-grained analysis as tendencies regarding which types of bass unigrams, bigrams, and trigrams should or should not be harmonized with RoO chords to meet Couperin’s style.

4. Summary of Findings and Conclusion

[4.1] Based on our empirical corpus analysis, our findings suggest a nuanced picture of the RoO:

- (Q1) In both major and minor keys, well over 60% of chords are covered by the RoO in the strict sense. If we include variations of the RoO chords (such as $\mathcal{V}^7$ instead of $\mathcal{V}$) or suspensions, this number increases to around 75%. The most frequent chords correspond to the chords given by the RoO. The top three ranks correspond with the chords on the *notes essentielles*: *finale* (I), *dominante* (V), and *mediante* (I⁶).
- (Q2) Whether or not a bass note is harmonized by a RoO chord depends greatly on that bass note’s scale-degree. We generally find that the *dominante* (̂), *finale* (i), and *soudominante* (̇) are the three most common bass degrees, and the chords used on those degrees correspond predominantly to the RoO, the only exception being the *soudominante* in major, where we find the root position chord IV) as the most frequent sonority, followed by ii⁶ and . Scale-degree ̂, too, typically carries a RoO chord, as do the “soft” degrees ̇ and ̂. Scale-degree ̂, in contrast, is less likely to be harmonized by a RoO chord.
- (Q3) There is a high probability (44.1%) that any two consecutive bass notes, whether connected by step or leap, will carry two RoO chords, which reflects the overall frequency of RoO chords in the unigram distribution.
- (Q4) Two adjacent *leaping* bass notes usually carry at least one RoO chord. In almost half the cases, both notes carry RoO chords. Longer segments of the RoO, however, are rare in compositional practice. RoO chords are more often reached and left by diatonic leaps than by steps, as shown in Example 15.
- (Q5) Nevertheless, the explanatory power of the RoO is generally higher for stepwise bass progressions.
- (Q6) Our findings suggest a hierarchy between stable degrees (*notes essentielles*) carrying consonant RoO chords (i, ̂, ̇) and soft degrees carrying dissonant chords (̇, ̇, ̂, ̂, ̇), the latter of which often contain dissonances resolving to consonances. This supports the idea of the RoO being compatible with both leaping and stepwise bass motion.
- (Q7a) Examining whether the RoO should be considered primarily a unigram model or primarily a model of stepwise bigrams, we found that, if RoO chords appear on soft degrees, the RoO refers primarily to scalar basses; if, however, RoO chords appear on stable degrees, basses tend to leap rather than move stepwise.
- (Q7b) Heinichen’s rule for leaps after soft degrees (preferring root-position chords on them) turns out to be a useful addition to Champion’s RoO, because our dataset reveals a high probability for root-position chords on soft degrees to be followed by leaps in the bass.
- (Q7c) Our comparison of the RoO with a baseline model has revealed that, as a theoretical model of Couperin’s harmonic idiom, it is
 - exceptionally well suited for explaining center chords of trigrams comprising two descending or two ascending diatonic steps in the bass, or a diatonic neighboring motion;
 - good for explaining chords in bigrams where the bass performs a diatonic stepwise motion, except for chords reached by a diatonically ascending bass;
 - not the best model for all other types of unigrams, bigrams, and trigrams.

[4.2] The analyses presented in this article suggest that Campion's RoO is more than a mere instruction for harmonizing a scale in the bass.⁽³⁰⁾ As outlined in section 3, the distinction between stable (*notes essentielles*) and soft degrees helps us to better understand how the RoO actually works: whereas the stable degrees can be approached and departed from invariably by leap, the soft degrees need a more nuanced treatment according to both the bass motion and the involved dissonant chords, which have to be resolved. The RoO as a theory of tonality that allows for both leaps and steps in the bass can also be found in sources like the anonymous treatise from Example 2 or later in Heinichen's concept of *Schema modorum* (1728, 903–16). The RoO essentially provides the chordal repertoire that is suited to clearly express tonality (in the sense of reference to a key) within our studied corpus; what applies to other repertoires must be investigated in subsequent studies. Our study corroborates the idea that the RoO should not be understood in a simplistic fashion but requires a more nuanced approach, one that takes into account a variety of factors, such as differences among scale-degrees, different types of bass motions (leap or step), ascending and descending steps, and optional suspensions.⁽³¹⁾ Further, Heinichen's rule that root-position chords are preferred before a bass leap may be understood as a valuable extension of Campion's RoO and reflects the practice found in Couperin.

[4.3] It is noteworthy that Campion was the first to refer to the RoO as a "règle." As suggested by a historical dictionary, "rule" (or "règle") can be translated as "law," "prescribed order," "acquired habit" or "model for imitation" (Frisch 1772, 1705). While terms such as "law" or "prescribed order" clearly carry deterministic and prescriptive connotations, "habit" and "model for imitation" are somewhat weaker terms, leaving room for individual freedom on the part of the musician and emphasizing the probabilistic nature of artistic choices that modern quantitative corpus research is capable of modeling and reflecting. The fact that rules are not an end in themselves but fulfill auxiliary functions is nicely captured in Claude Yvon's entry for "Art" in Diderot's *Encyclopédie*:

Instruments and rules are like muscles added to arms, and springs accessory to those of the mind. The purpose of all art in general, or of any system of instruments and rules conspiring to the same end, is to impress certain determined forms on a foundation given by nature; and this foundation is either matter, or spirit, or some function of the soul, or some production of nature.
⁽³²⁾ (Yvon 1751)

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Footnotes

1. We would like to thank the anonymous reviewers for their helpful suggestions on how to improve the text.
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2. Joel Lester summarizes this as follows: "the *règle* promoted recognition of the manner in which harmony expresses a key" (1992, 72). See also [Holtmeier 2007](#) and [2009](#).
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3. In terms of its educational application, this was developed by Hans Aerts in 2018: <https://glarean.mh-freiburg.de/kartimento/#/>
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4. "afin de faciliter les moyens de parvenir plus promptement à la composition" ([Masson 1699](#), 9).
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5. Campion and Dandrieu are largely in agreement. However, there is a difference in the ascending second scale-degree in the minor key ($\frac{3}{\flat 6}$ in Campion and $\frac{3}{\sharp 4}$ in Dandrieu). In our analysis, we follow Dandrieu on this point, as the $\frac{3}{\sharp 4}$ chord is the more common variant.
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6. "Pour accompagner, il faut considerer dans quelle de ces octaves on est, et à combien du ton, commençant à compter par la premiere, montant ou descendant l'armonie; c'est la maniere la plus sûre et la plus facile de donner l'accord necessaire, et je ne croy pas que l'on ait jusqu'ici rien donné de plus general et de plus simple."
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7. "L'exposition de ces deux planches sont de contre-point simple; car on peut monter ou descendre les octaves par d'autres accords figurez, comme de sixtes de septièmes et cetera."
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8. "Le diéze est donc une notte sensible, qui annonce l'octave du semi-ton au-dessus."
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9. "La Regle des octaves n'est pas moins de consequence pour ceux qui chantent, que pour ceux qui joüent des Instrumens à partie seule; car sçachant dans quelle octave ils entrent, ils se trouvent préparez, le diéze portant la même consequence aux dessus qu'aux basses;"
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10. “La grande affaire, est de sçavoir quand on change d’octave;”

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11. “. . . parce que le triton ne se fait qu’à la quatrième du ton.”

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12. “Il est icy accompagné de la sixte et de la tierce mineure, ordinairement il est accompagné de la sixte et de la seconde, et c’est une élégance de l’accompagner de la tierce mineure, le Compositeur est obligé de la chiffrer avec le triton; car le triton étant seul, est accompagné de la seconde et sixte.”

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13. Similarly, Olga Sánchez-Kisielewska (2017, 115) states that “in the language of music, the Rule of the Octave is not exactly a collocation: musical utterances rarely feature complete scales in the bass. Instead, the Rule constitutes a meta-collocation of sorts, a chunk of chunks that contains shorter harmonic progressions that appear with high frequency in tonal music. [. . .] But because the Rule also constitutes a whole progression with its own internal logic and musicality, students can learn, practice, and remember it as a unit, which makes the Rule of the Octave a cognitively efficient tool to teach its many subsets at once.”

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14. This anonymous source can be found in the Biblioteca della musica di Bologna, 120(5) (Olim Cod. 022:11), <http://www.bibliotecamusica.it/cmbm/scripts/gaspari/scheda.asp?id=2441>. A similar approach can be found in Heinichen 1728, 905.

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15. Authors such as Denis Delair (1690) have given a catalogue of “accompagnements extraordinaires,” and Campion uses this attribute in the same sense. See also Menke 2020c, 108–9 and Menke 2024, 126–27.

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16. “Denn wir haben [. . .] alle unsere Schemata modorum so eingerichtet, daß man die Bass-Claves mit ihren darüber stehenden Signaturen nach Gefallen verwechseln, und also per gradus oder per saltus gehen könne, wie man will.”

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17. “kommt aber die 2da modi mitten im Sprung zu stehen, so fället die 5te natürlicher aus.” See also “Leaping bass tones” in <https://glarean.mh-freiburg.de/kartimento/#/compose>.

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18. See Hentschel and Rohrmeier 2023 and Hentschel et al. 2021. EPFL stands for École Polytechnique Fédérale de Lausanne.

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19. <https://github.com/DCMLab/standards>

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20. The datasets can be downloaded from https://github.com/DCMLab/couperin_concerts v2.2 (DOI <https://doi.org/10.5281/zenodo.15027240>) and <https://github.com/DCMLab/corelli> v2.7 (DOI <https://doi.org/10.5281/zenodo.15292696>).

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21. Concerning the performance practice of Couperin’s *Concerts*, see Bötticher and Menke 2021.

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22. “Signor Corelli, dont j’aimera Les Œuvres tant que je vivray.”

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23. Whenever a score is changed, these files can be re-extracted using the MuseScore parsing library *ms3* (Hentschel and Rohrmeier 2023). This library also allows us to split the annotation labels into their various features.

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24. In this corpus, it is not always clear what constitutes an autonomous movement or what is better to be regarded as a movement with tempo changes.

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25. The dataset has been published as a subset of the Distant Listening Corpus, see [Hentschel et al. 2025](#).

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26. See also Rameau’s demonstration of a *basse fondamentale* under the RoO, where he uses only “6” as figure but uses a $\frac{6}{4}$ chord in his realization, see [Rameau 1722](#), 212.

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27. For the annotation criteria, see <https://github.com/DCMLab/standards>.

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28. See [Rohrmeier and Cross 2008](#), [Moss et al. 2019](#), [Moss 2019](#), and [Piantadosi 2014](#).

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29. We call $\mathcal{V}_{top-k}$ a baseline because, for the full corpus, no other vocabulary of size k can perform better.

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30. See also, for instance, [Holtmeier 2009](#) and [Nicolas 2019](#), who even uses a Couperin Concert to demonstrate this idea of the RoO.

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31. A good example of a playful exploration can be found at <https://glarean.mh-freiburg.de/kartimento/#/9/25/2026>.

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32. “Les instruments et les règles sont comme des muscles surajoutés aux bras, et des ressorts accessoires à ceux de l’esprit. Le but de tout art en général, ou de tout système d’instruments et de règles conspirant à une même fin, est d’imprimer certaines formes déterminées sur une base donnée par la nature ; et cette base est ou la matière, ou l’esprit, ou quelque fonction de l’âme, ou quelque production de la nature.”

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