The Insufficiently Stimulated Ear: A Corpus Study of Dissonance Treatment from DuFay to Victoria

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I'd like to begin by recognizing the contributions of my co-author, Andie Sigler, who unfortunately can't be here today.

Dissonance treatment, as one of the main issues in polyphonic composition, was a major nexus of stylistic evolution in Renaissance music, and computer-assisted analysis enables us to examine it at a greater scale than ever before. Today, we present the results of a corpus study of over 2,100 movements of Renaissance polyphony carried out with the aid of a new software environment for music analysis.

[SLIDE 2] We'll begin by briefly outlining the two sources of our corpus and the software used to analyze it. The first source is the scores of the Josquin Research Project at Stanford. The JRP contains over 1100 movements from composers of the generation of Josquin and his immediate predecessors such as DuFay and Ockeghem. The second source is a corpus of 705 mass movements of Palestrina, originating from the 1992 dissertation of John Miller at Indiana, and 261 mass movements and motets by Victoria, obtained from SIMSSA's ELVIS database at the illustrious McGill University. There is, unfortunately, a substantial historical gap between the two branches of our corpus, so while we will make some extrapolations about developments between them, these should be seen as tentative.

Our analysis was performed using an interactive music analysis browser programmed by my coauthor Andie together with her collaborator Eliot Handelman. [SLIDE 3] The software looks at the interval between all pairs of notes and when this interval is dissonant, attributes the

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"the ear barely notices this dissonance, not being sufficiently stimulated by it to comprehend it fully." - Zarlino, *The art of counterpoint* (1558)

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Corpus:

-The Josquin Research Project (1169 movements)
http://josquin.stanford.edu/
Composers include Josquin des Prez (1450–1521), Pierre de la Rue (1452–1518), Johannes Ockeghem (1410-1497), Guillaume DuFay (1397–1497), etc.

- Giovanni Pierluigi da Palestrina (1525/7–1594) masses (705 movements) and Tomás Luis de Victoria (1548–1611) sacred music (261 movements)
from the ELVIS database
http://elvisproject.ca/

Dissonance attribution

Andie Sigler, Jon Wild, and Eliot Handelman. "Schematizing the Treatment of Dissonance in 16th-Century Counterpoint." In *ISMIR*, pp. 645-651. 2015.

dissonance to one or the other of the notes of the pair according to a set of rules. We do not have time to explain this process of dissonance attribution further, but anyone interested can read a paper that Andie coauthored on this subject, listed in the bibliography on the handout.

The software then sorts this dissonance using dissonance "schemas" [SLIDE 4] specified in a specially written programming language. These schemas specify logical conditions concerning features such as metric placement and melodic and harmonic intervals. A simple example is the schema for a lower neighbour : if the dissonant note is metrically weak, *and* if it is approached by descending step, *and* if it is left by ascending step, then: it is a lower neighbour. (Note that "metric weakness" is defined relative to the length of the note in question.) By varying, adding, or removing conditions, we can create schemas to label most any dissonant idiom. The software can display these schemas as annotations upon a score [SLIDE 5], allowing us to verify that they are working as expected, and to examine those dissonances which our schemas have failed to classify. (Note that we exclude cross-relations and diminished fifths from our results because, in this repertoire, these intervals pose questions of *musica ficta* that put their status as dissonances in doubt.)

Our first schema definitions were written together with Jon Wild for the late Renaissance style of Palestrina and Victoria. These definitions successfully categorize virtually all dissonant notes in the music of Palestrina and Victoria [SLIDE 6], failing to categorize less than 0.3% of their dissonance. This is both evidence that the computer-analysis is proceeding smoothly, and also a vindication of the traditional view that highly regularized dissonance treatment reached an apogee in the music of such composers. However, in the earlier scores from the Josquin Research Project [SLIDE 7], these same schema definitions fail to categorize nearly 6% of dissonance, a rate of failure over twenty times higher than that in Palestrina and Victoria. In the music of

Dissonance schemas

logical conditions for identifying a dissonant idiom
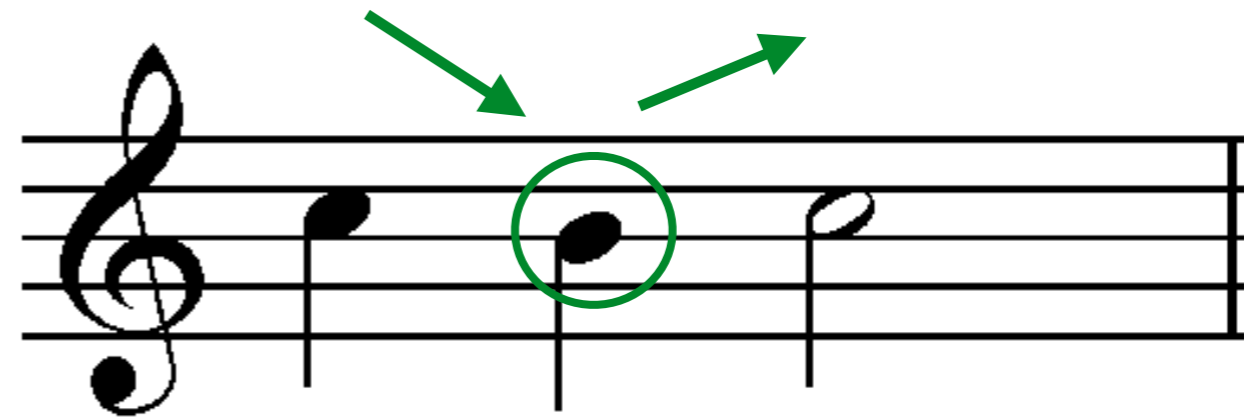
Schema for a lower neighbour:

metrically weak
AND
approached by step down
AND
left by step up

Annotated score display
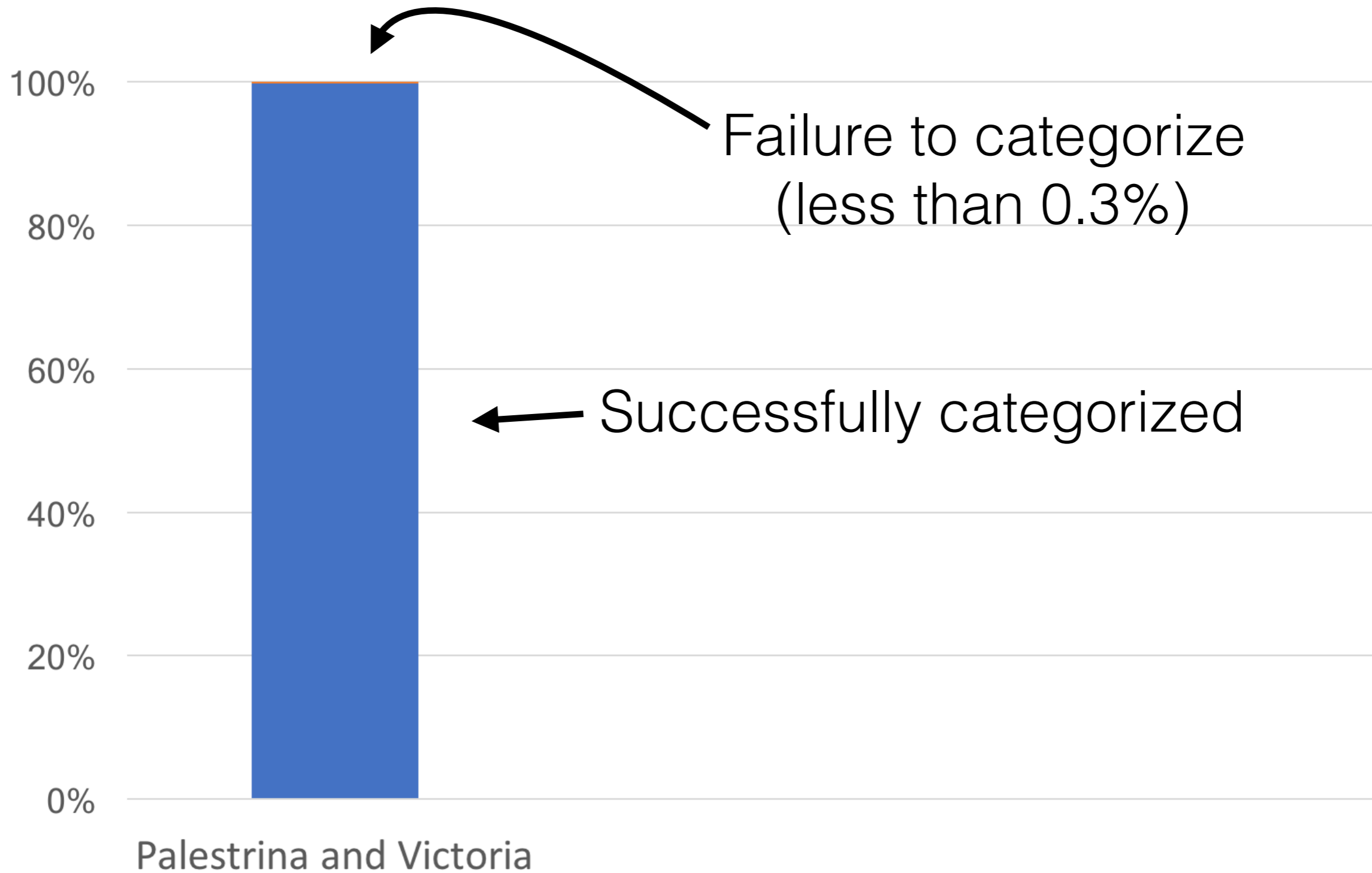

Legend

P – Passing Tone
S – Suspension
G – Agent (of Suspension)
Q – Legal Dissonant Third Quarter
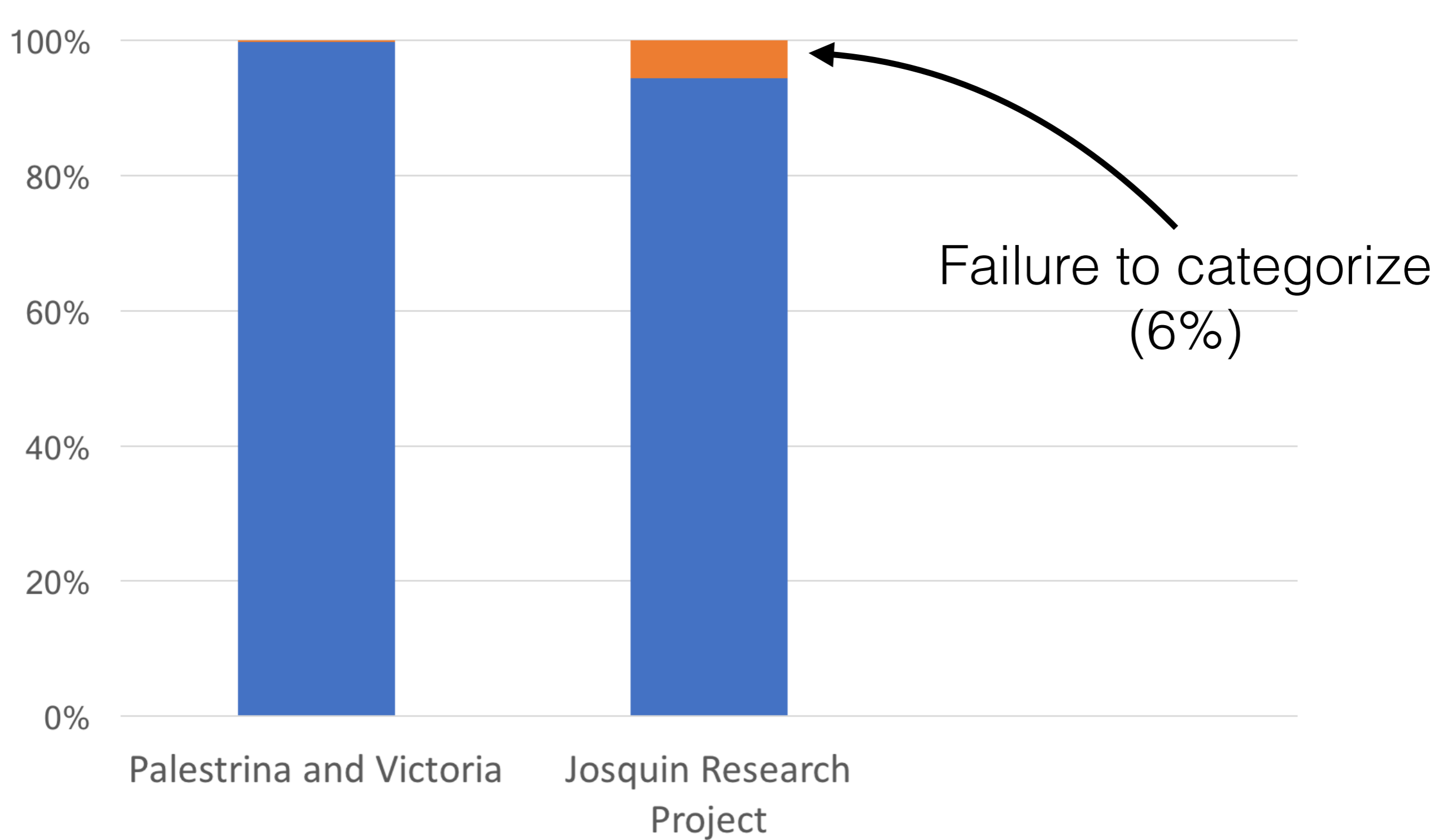
Rate of successful dissonance categorization

using schemas based on Schubert 2008

Failure to categorize
(less than 0.3%)

Successfully categorized

100%

80%

60%

40%

20%

0%

Palestrina and Victoria

Rate of successful dissonance categorization
using schemas based on Schubert 2008

Failure to categorize (6%)

Palestrina and Victoria

Josquin Research Project

certain composers, such as Ockeghem, [SLIDE 8] this rate of failure rises to nearly one in ten dissonances. The question animating the next stage of our research was "what accounts for these uncategorized dissonances?"

To answer this question, we expanded our schema definitions to allow for a much wider range of dissonant idioms, examining uncategorized dissonances and inquiring whether there was an appropriate idiom they might be said to belong to. An example is what Ingrid Ceulemans has called the "note libre" [SLIDE 9]: a metrically weak dissonance approached by leap and left by step. For example, in this passage from Ockeghem's Missa De Plus en Plus, the C in the first voice forms a dissonant seventh against the D of the middle voice. Because it occurs on the metrically weak fourth half-note, and because it is approached by leap and left by step, it is a "note libre."

[SLIDE 10] Another example of a dissonant idiom used by the earlier composers is the "retardation" or upward-resolving suspension. Like ordinary suspensions, retardations sometimes even receive ornamental resolutions, as in this passage from Ockeghem's Missa Quinti Toni. On the downbeat of m. 20, the A in the first voice forms a dissonant seventh against the bass. This seventh is then resolved upwards to an octave on B-flat, but before it does, it is ornamented by the consonant leap down to F. In this particular case, Ockeghem may have ornamented the resolution in order to add a consonance between the displaced parallel octaves on A and B-flat.

Computers, as those of you who work with them undoubtedly know, can be infuriating. In particular, they insist on doing what you say, rather than what you mean, which means that you must be uncomfortably rigorous about saying exactly what you mean. In our case, this rigour led us to identify what we believe is a previously undescribed dissonant idiom. To explain, we must first briefly explore what we call "onset conditions", [SLIDE 11] or the various ways in which a

Rate of successful dissonance categorization
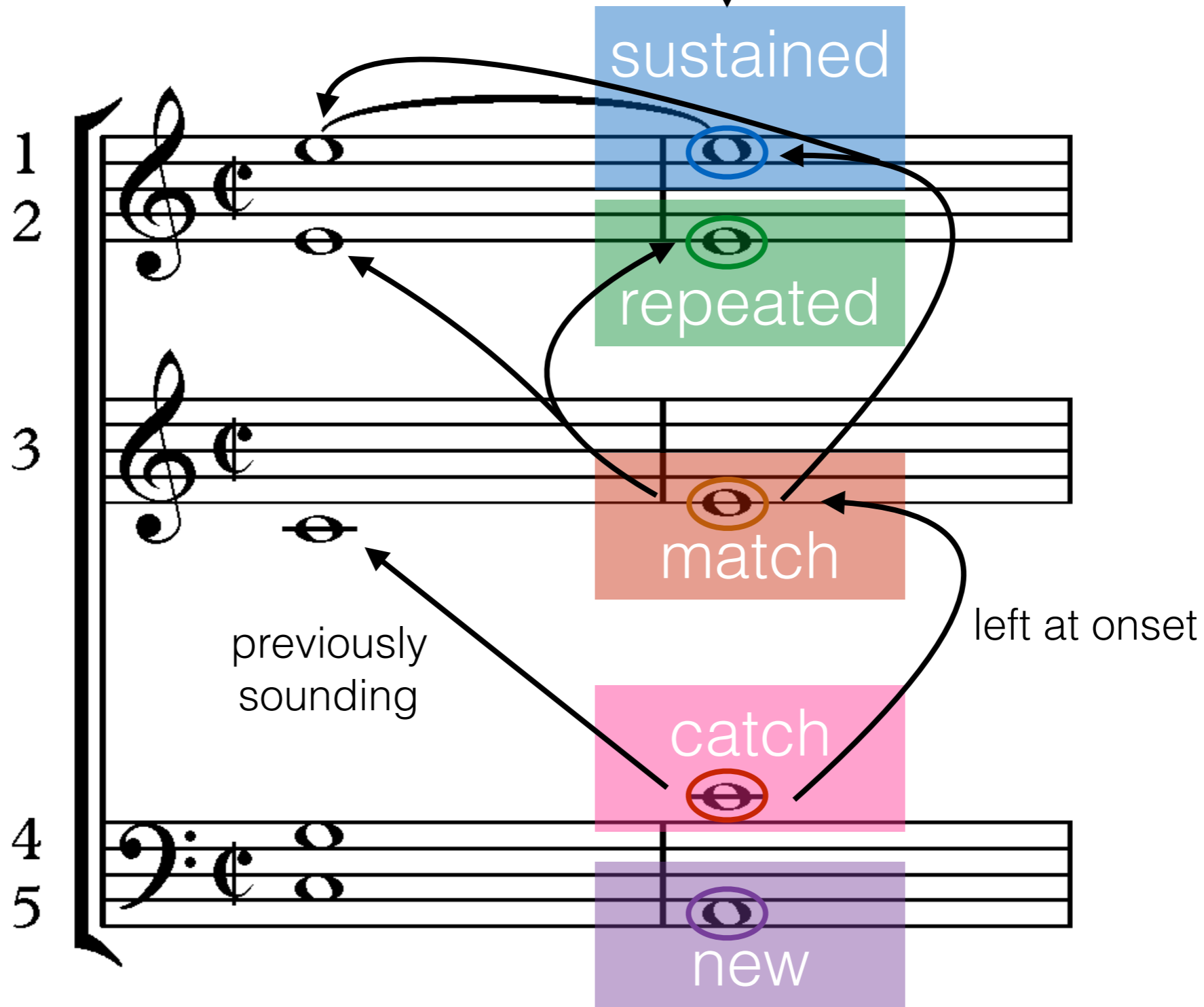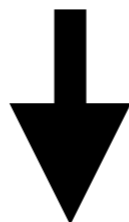
using schemas based on Schubert 2008

Failure to categorize (9%)

Ockeghem *Missa de Plus en Plus*, Gloria, mm. 87–88

9

Retardation with ornamental resolution
(upwards resolving suspension)

upwards resolution

ornamental leap

7th

8ve

8ve

Ockeghem *Missa Quinti Toni*, Sanctus, mm. 19–20

Onset Conditions

sustained

repeated

match

catch

new

previously sounding

left at onset

Pitch classes: C E G   A C E

11

note can sound a pitch in relation to its context. To illustrate, consider these two consonant chords and, in particular, the condition under which each pitch in the second chord is sounded. The E in the first voice is simply sustained from the previous note, so we say that its onset condition is "sustained". Similarly, the E in the second voice is "repeated". The fifth voice simply sounds a "new" pitch class, A, not among the three pitch classes—namely, C, E, and G—that were previously sounding, so its onset condition is "new". The onset conditions of the two remaining voices are somewhat more subtle, however. The E of voice 3 "matches" the pitch-class that is sustained and repeated in voices 1 and 2 respectively, and so we call its onset condition "match". And finally, the C in voice 4 sounds a pitch-class previously sounding in voice 3, but left at the moment of onset : since we can think of voice 4 as "catching" the pitch-class of voice 3, we call this onset condition "catch".

To quickly review these new onsets, we have a match onset [SLIDE 12] when the pitch class of a given note was previously sounding *and* when it remains sounding at the onset of the note. We have a catch onset when the pitch class of a given note was previously sounding, *but* it is no longer sounding at the onset of the note. A third situation that should not be confused with either of these is when a given note sounds the same pitch class as another voice, but this pitch class was *not* previously sounding. In this case, we simply have simultaneous onsets to the same new pitch-class, and the onset condition of both voices is "new".

[SLIDE 13] Match and catch onsets can lead to simultaneous dissonant attacks, which are otherwise foreign to the Renaissance style. Consider, for instance, this excerpt from Victoria's Magnificat Primi Toni (Todos). On the fourth quarter note, the middle voice leaps down to G, forming a simultaneously attacked dissonant fourth with the C of the top voice. However, the leapt-to G in the middle voice "matches" the sustained G of the bottom voice and we therefore
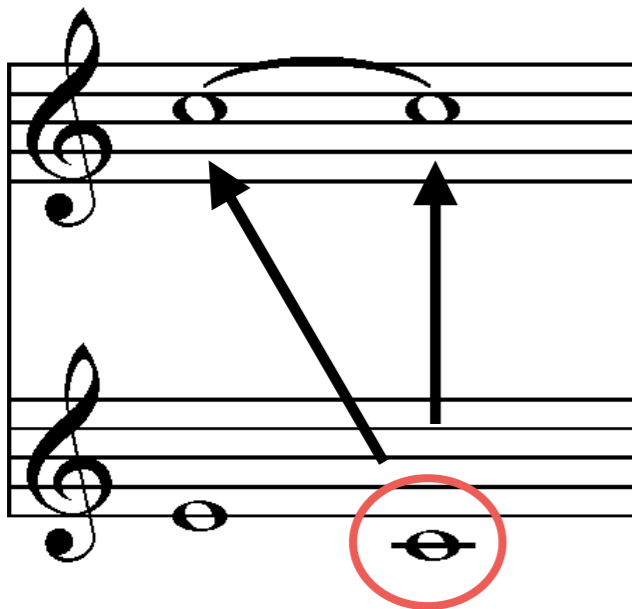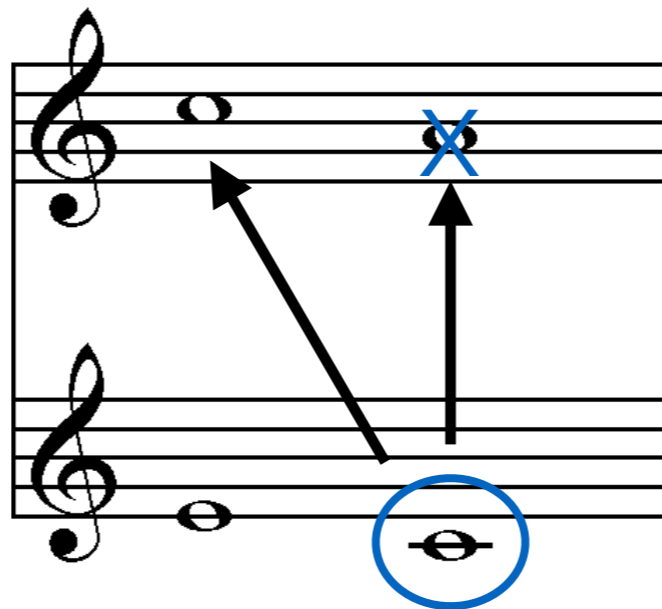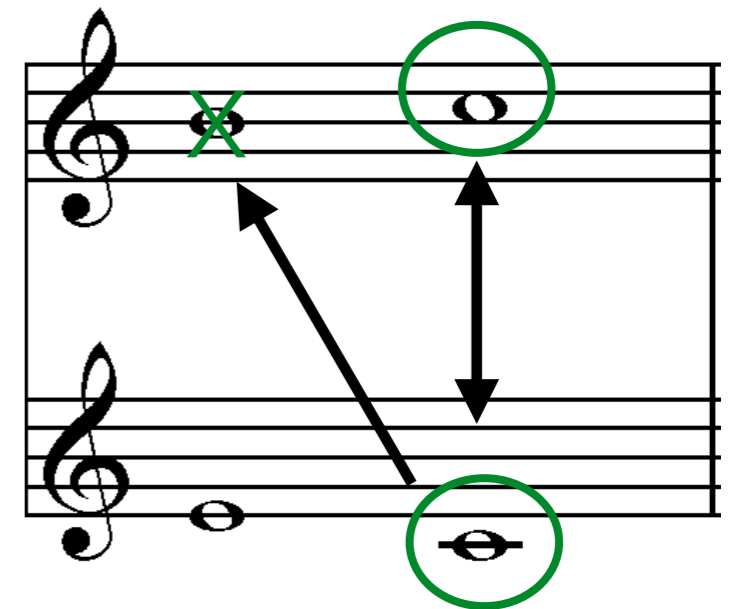
Simultaneous Dissonant Attack
involving a "match" onset

4th

match
(previously sounding and still sounding)

Victoria *Magnificat Primi Toni (Todos)*, mm. 51–52
Some voices omitted

say that it inherits the sustained note's consonance. Although Jeppesen does not use our "match" framework for describing such simultaneous attacks, he calls such dissonances "parasitic", implying that, like parasites living off of the resources of their host, such notes leech consonance from the notes that they match.

Catch onsets lead to somewhat more subtle scenarios. [SLIDE 14] Consider this brief excerpt from Ockeghem's Missa Quinti Toni. The quarter-notes E-flat and F at the end of bar 1 form a simultaneous attack on a dissonant ninth. When we analyze dissonance treatment, we first must know "whose fault is the dissonance?" but here, even if we allow ourselves to look beyond the dissonant pair, it is not obvious which note to blame the dissonant interval on, because both notes are consonant with the C in the middle voice, forming a 6th from E-flat to C, and a 4th from C to F (fourths, of course, are dissonant when the lower pitch of the fourth is in the bass, but that is not the case here). Observe, however, that the F in the upper voice is a catch [SLIDE 15], sounding the pitch class that was previously sounding in the bass, but which is left at the moment of onset. The catch "inherits" consonance and it is the E-flat, therefore, that is properly considered the dissonant pitch : it is, in fact, a cambiata. Recognizing the catch allows us to understand why Ockeghem might have considered the dissonance treatment of this passage well-formed. Whenever such a simultaneous dissonant attack involving a catch onset occurs, we speak of the "catch idiom." As far as we know, we are the first to describe this idiom. It accounts for over 1% of dissonances in our total corpus [SLIDE 16], a similar proportion to better known idioms such as the incomplete cambiata and the "fake suspension" or "consonant fourth", and over twice as common as upper neighbours.

After this expansion of our schema definitions [SLIDE 17], we were able to reduce the failure rate threefold for the scores of the Josquin Research Project, bringing it from nearly 6% to

Simultaneous Dissonant Attack
involving a "catch" onset

Ockeghem *Missa Quinti Toni*, Gloria, mm. 11–12

Ockeghem *Missa Quinti Toni*, Gloria, mm. 11–12

Prevalence of Catch Idiom

Rate of successful dissonance categorization
with expanded schemas

Failure to categorize (<2%)
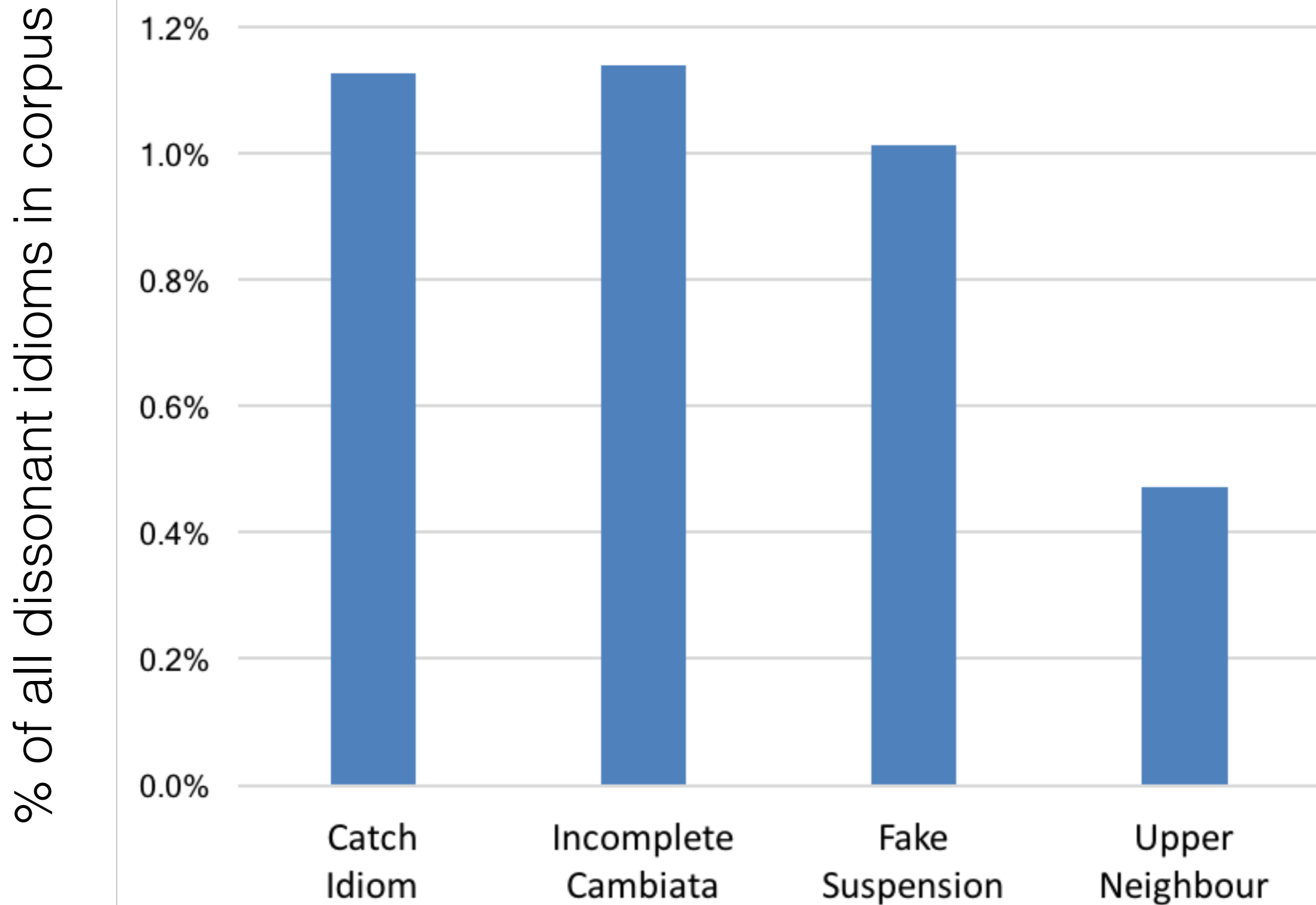
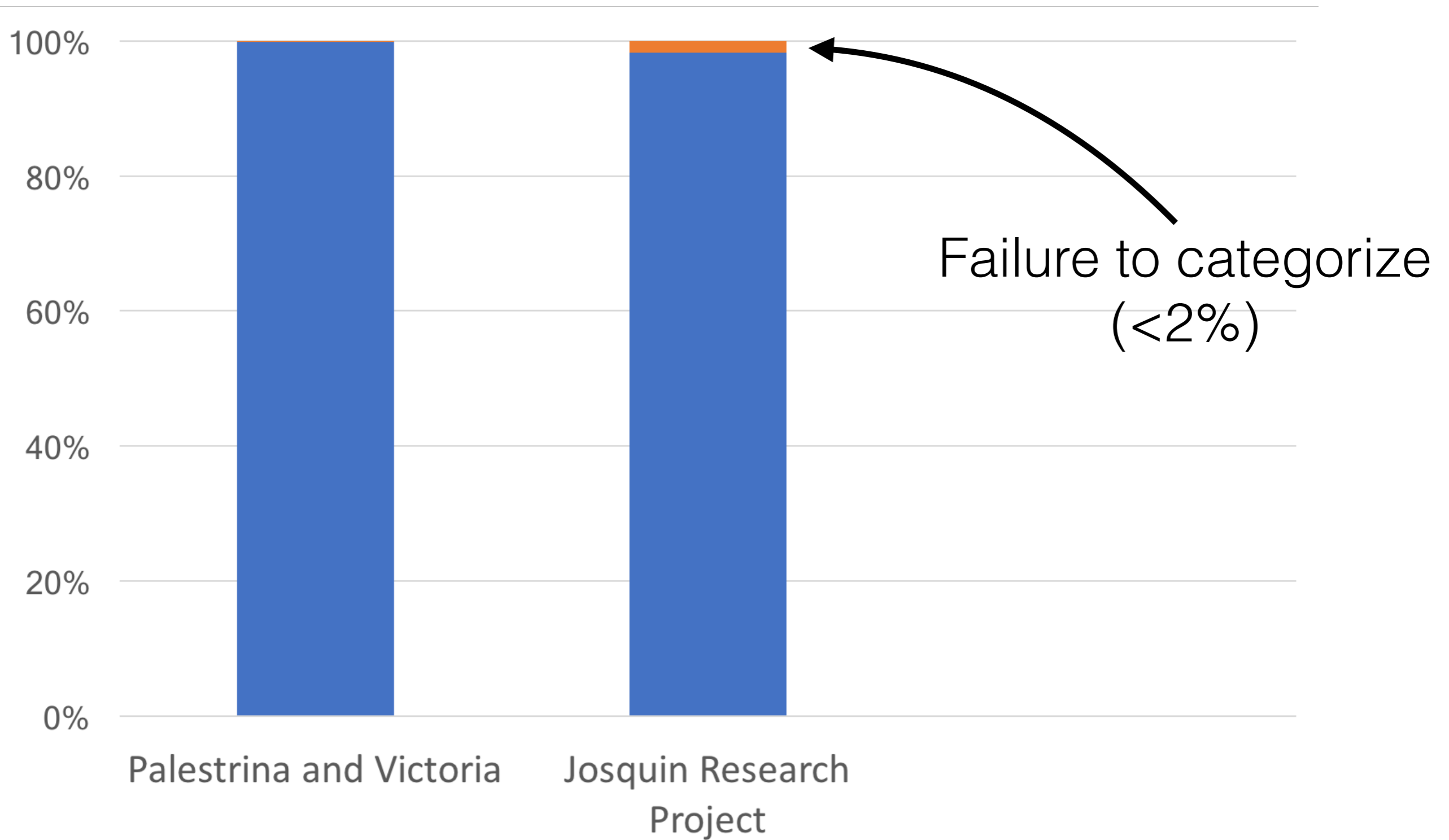below 2%, with reduction to a similar level for even the most recalcitrant composers such as Ockeghem [SLIDE 18]. It should not be seen as a failure of our algorithm that this is still much higher than the level of uncategorized dissonance in Palestrina and Victoria. It would certainly be possible to define schemas that could categorize 100% of the dissonance in this—or indeed in any other—music. We could, for instance, categorize all otherwise uncategorized dissonant pitches into those above and including middle C, and those below middle C. This would clearly be silly: categorizations are only worthwhile if they meaningfully represent some feature of the music. Our failure to categorize some dissonance reflects a fact about the music under study: dissonance in the earlier composers of our corpus simply does not always present itself in the guise of recognizable idioms. We are satisfied that our dissonant idiom definitions are reasonably complete, and that they form an appropriate basis to begin asking questions about dissonance treatment in this repertoire.

The first such question we might ask is simply "how much dissonance does each composer use?" Before we can answer this question, however, we must answer another, namely, "what do we mean by 'how much dissonance?' " To illustrate the different ways in which we might answer such a question, consider this brief excerpt [SLIDE 19]. We might choose to count the number of dissonant notes, here two, and divide it by the total number of notes, here five, thereby measuring the *percentage of dissonant notes*, here two-fifths or forty percent. But some dissonant notes are long, while others are short, and some happen simultaneously, while others do not. So we might instead choose to divide the sum of all dissonant durations, here three quarters, [SLIDE 20] by the total duration, here three halves, and thereby measure the percentage of time there is at least one dissonance sounding, which we call the *percentage of duration dissonant*, here 50%.

Rate of successful dissonance categorization
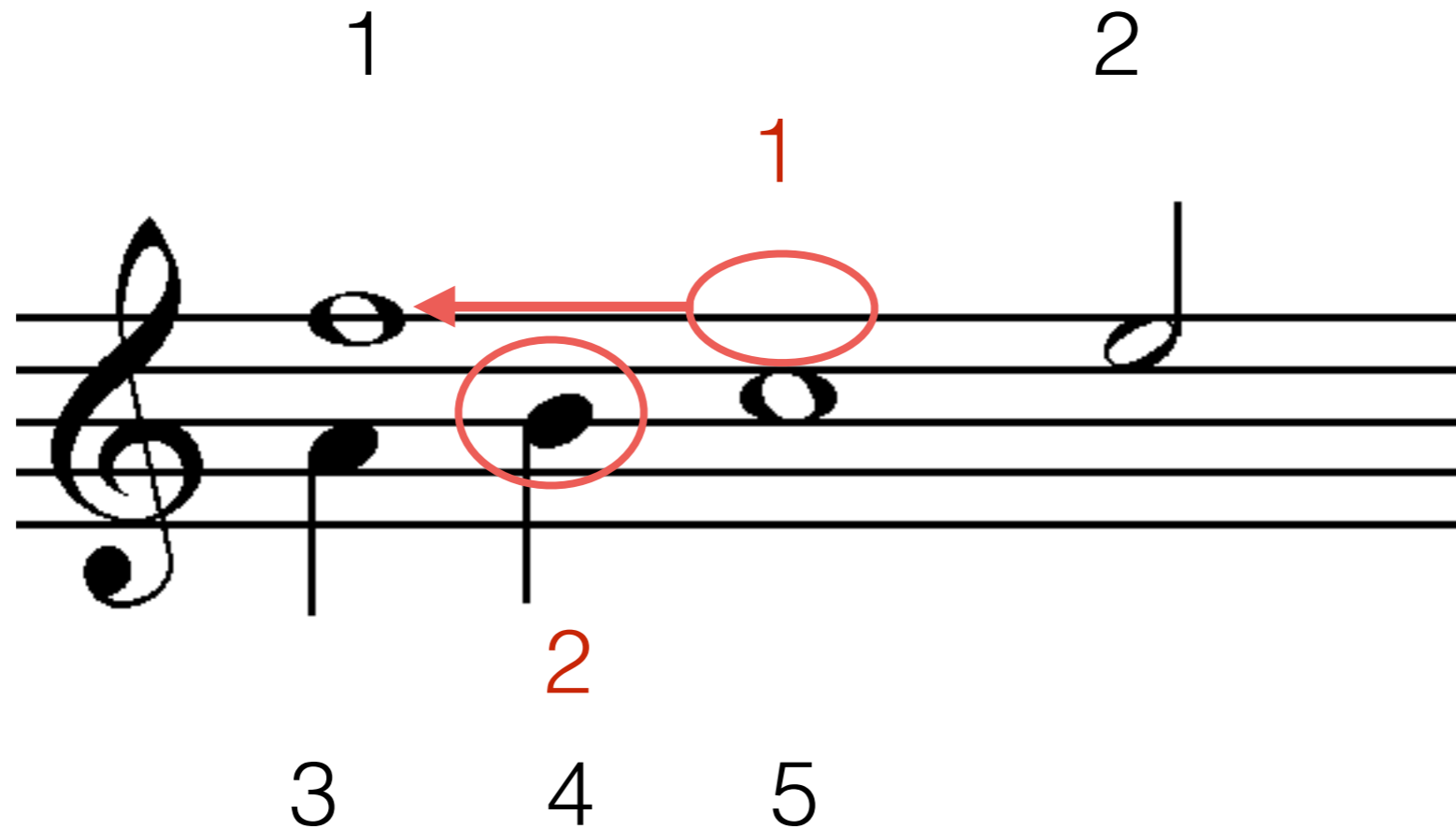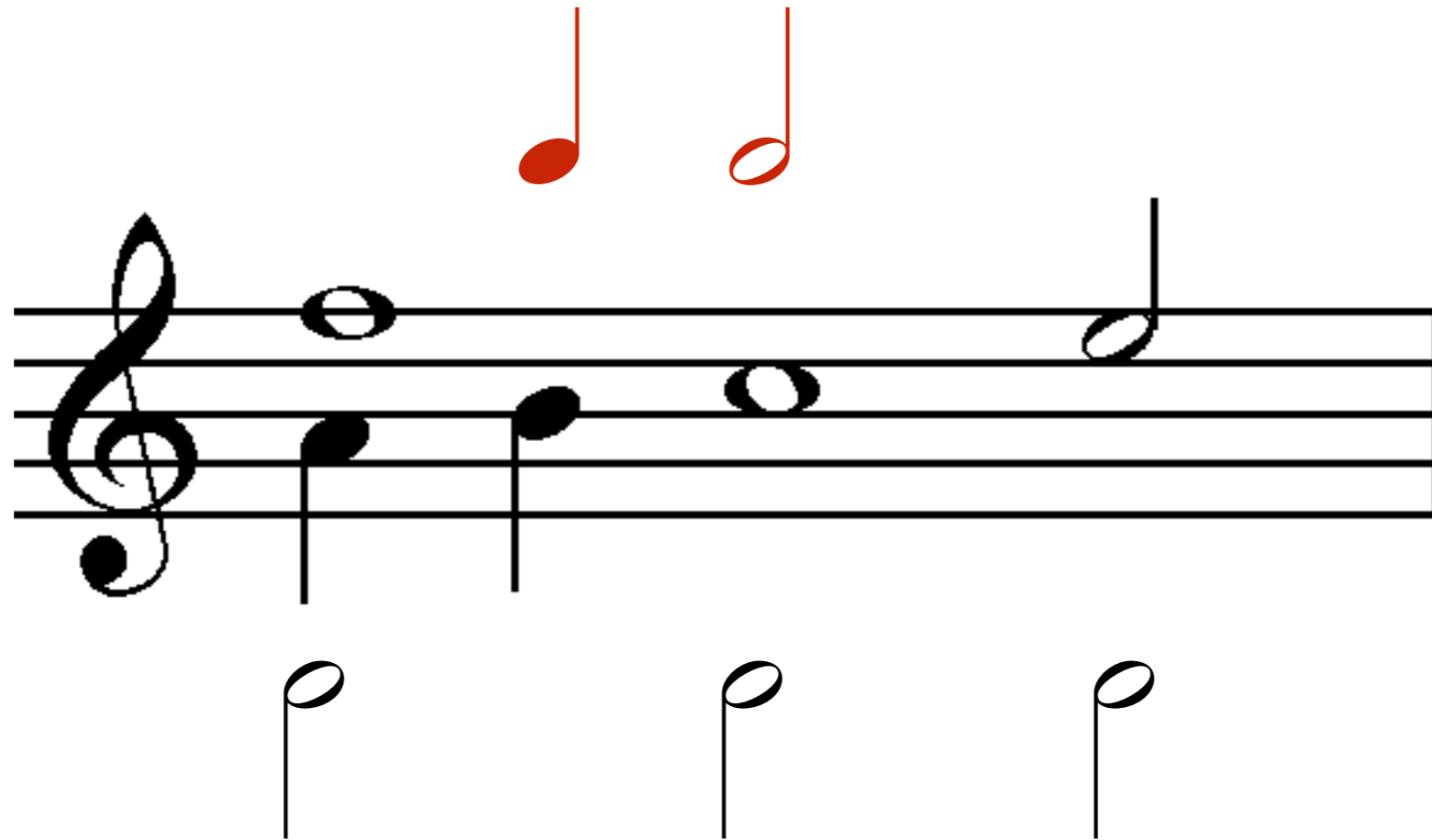*with expanded schemas*

Failure to categorize (2%)
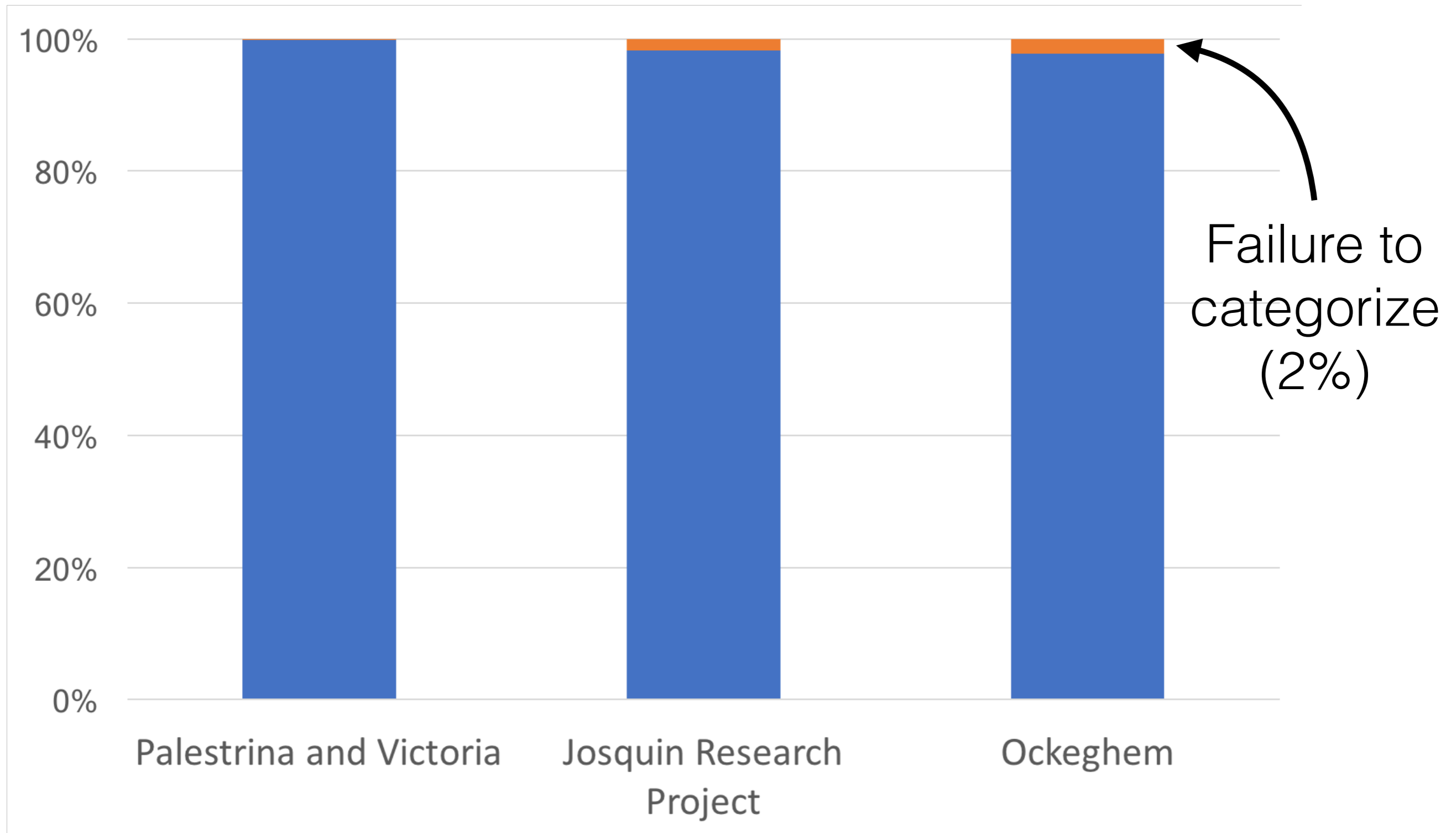
Number of dissonant notes: 2
÷ Number of notes: 5
= Percentage of dissonant notes: 40%

Dissonant durations: 3 x ♩
÷ Total duration: 3 x 𝅗𝅥
= Percentage of duration dissonant: 50%

In this table, we show both of these metrics of overall dissonance for a few of the best-represented composers in our corpus [SLIDE 21]. So, for instance, the blue column shows that about 15% of Palestrina's notes are dissonant, about one in every seven notes, while the orange column shows that about 22% of his durations are dissonant —there is a dissonance sounding in at least one voice about one-fifth of the time during the average Palestrina piece. The chart has a number of surprising features. First, by either metric, we find similar percentages in the works of composers widely separated in both time and style— for instance, the percentage of dissonant notes in Ockeghem and Victoria, which is about 11.5% in either case. At the same time, we find widely divergent percentages among stylistically and chronologically close composers. Compare the 11.5% of dissonant notes in Ockeghem with the 16% of notes in the music of his friend Busnoys. Even more unexpected, both metrics suggest that Palestrina is *more* dissonant than Ockeghem. This is clearly in conflict with the received wisdom that, as Carl Dahlhaus puts it, composers "in the central tradition culminating in Palestrina Style [...] sought the *reduction* of dissonance." Rather than voiding this received wisdom, however, this result is better seen as voiding the idea that merely tabulating dissonant notes or durations can give us a reliable impression of the subjective dissonance of a passage. Take these two exercises in third species counterpoint [SLIDE 22]. Since I have simply rearranged the quarter notes sounding against each note of the cantus firmus, each contains precisely the same proportion of both dissonant notes and durations. Nevertheless, while my counterpoint instructor might be willing to let my first attempt stand [play], she would be distinctly displeased by my second [play]. This is a fun way of making the perhaps obvious point that our perception of "dissonance" is a question of the *treatment* of dissonance, not of its simple quantity.

Metrics of Overall Dissonance

Legend: ■ % of notes dissonant ■ % of duration dissonant

Composer	Value 1	Value 2
DuFay 1397–1474		
Ockeghem 1410-1497	11.5%	
Busnoys 1430-1492	16%	
Martini 1435-1497		
Rue 1452-1518		
Josquin 1450-1521		
Palestrina 1525-1594	15%	22%
Victoria 1548-1611	11.5%	

21
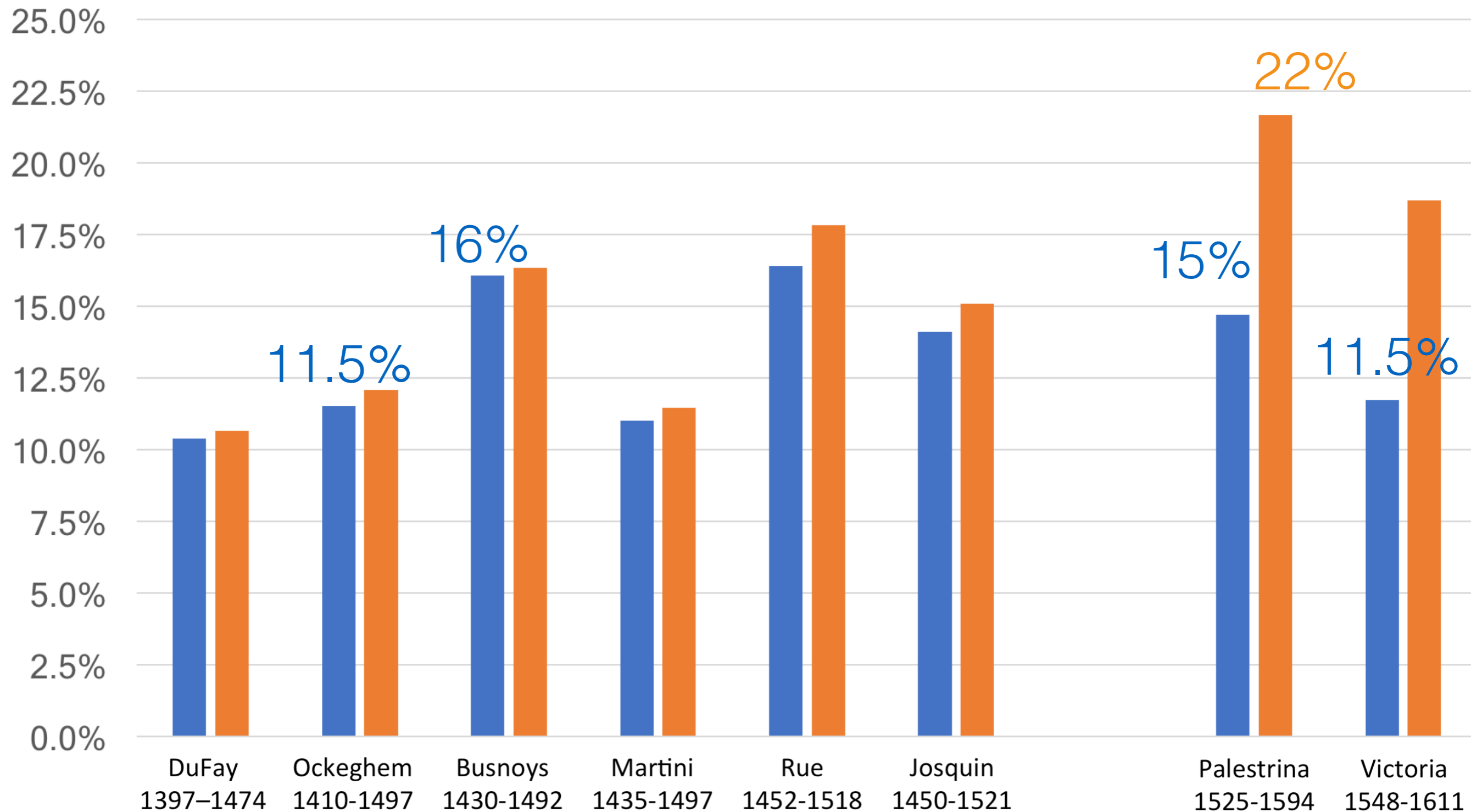
# Two attempts at third-species counterpoint

One particular result from the previous chart nevertheless intrigued us [SLIDE 23]. This is the convergence towards the same value of the two metrics of total dissonance in each of the earlier composers, contrasted with their divergence in the later composers. The explanation is that, in the music of any well-behaving Renaissance composer, there is a very high correlation [SLIDE 24], over 90%, between the average number of voices that each composer uses and the difference between the two metrics of dissonance in his works. To illustrate why this should be so, consider this simple passage [SLIDE 25] containing a dissonant passing tone. It is four half-notes long, one of which is dissonant, so 25% of the duration is dissonant. Similarly, it contains four notes, one of which is dissonant, so 25% of the notes are dissonant. There is, clearly, no difference either way. But consider what happens if we take the same passage again, only we add another voice to it. As before, one of four half-note durations is dissonant, so the percentage of duration dissonant remains 25%. But the number of total notes has increased, to five, while the number of dissonant notes has remained one, and so only 20% of the notes are now dissonant. If we measure dissonance in this second way, we have reduced the total dissonance of the passage by a fifth. In other words, a larger number of voices leads to a greater proportion of dissonant durations relative to the proportion of dissonant notes; because the later composers of our corpus tended to write for larger forces, their works therefore contain relatively more dissonant durations than dissonant notes.

Let's look now at the usage of specific dissonant idioms. [SLIDE 26] In the following we express the prevalence of dissonant idioms as a percentage of all dissonances, so if a composer writes 10 dissonances and three are lower neighbours, the percentage of lower neighbours is 30%. We could also express the prevalence of idioms as a percentage of all notes, but because the

Metrics of Overall Dissonance
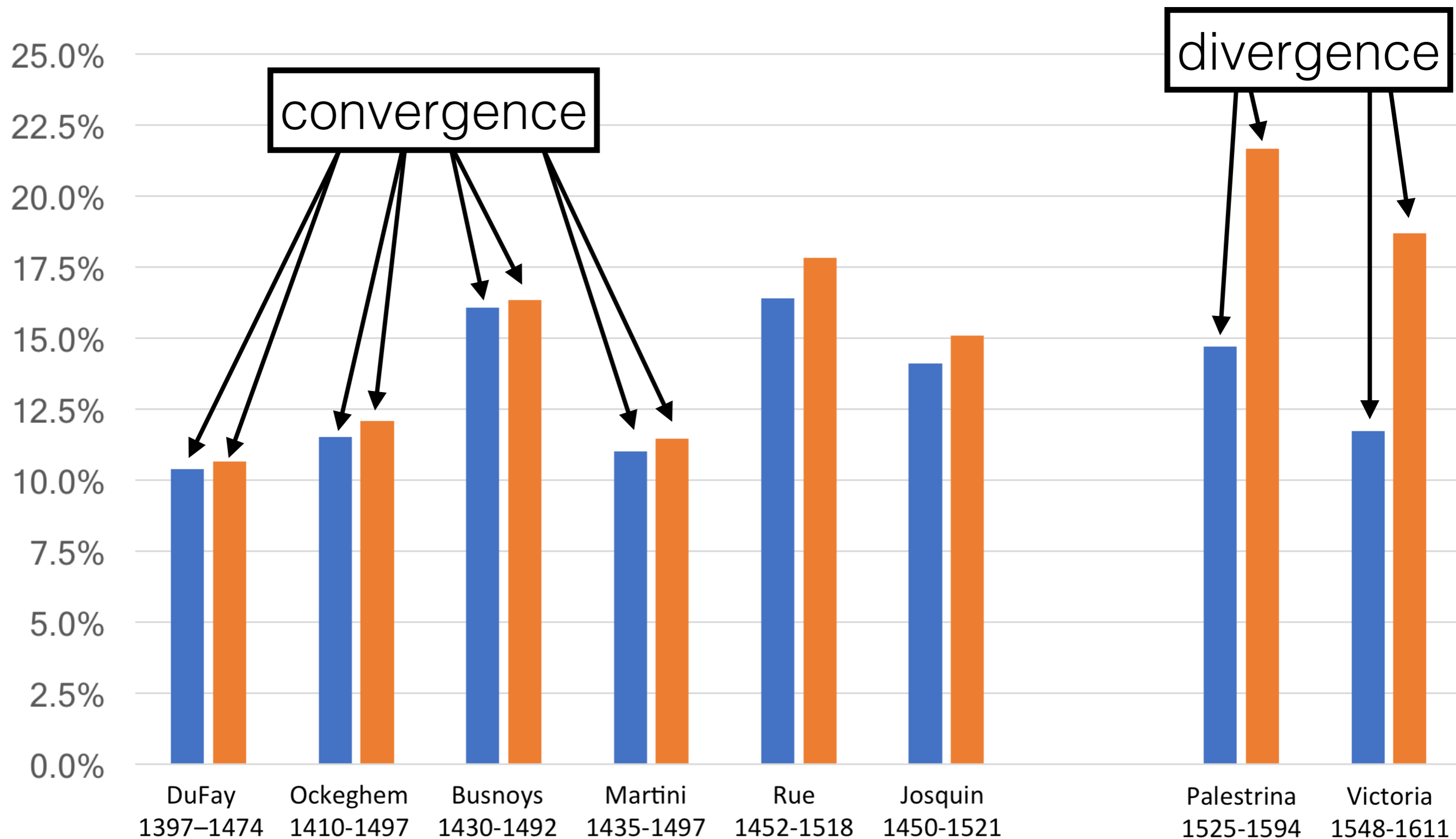
Correlation = 0.92 between average number of voices and difference between the two metrics
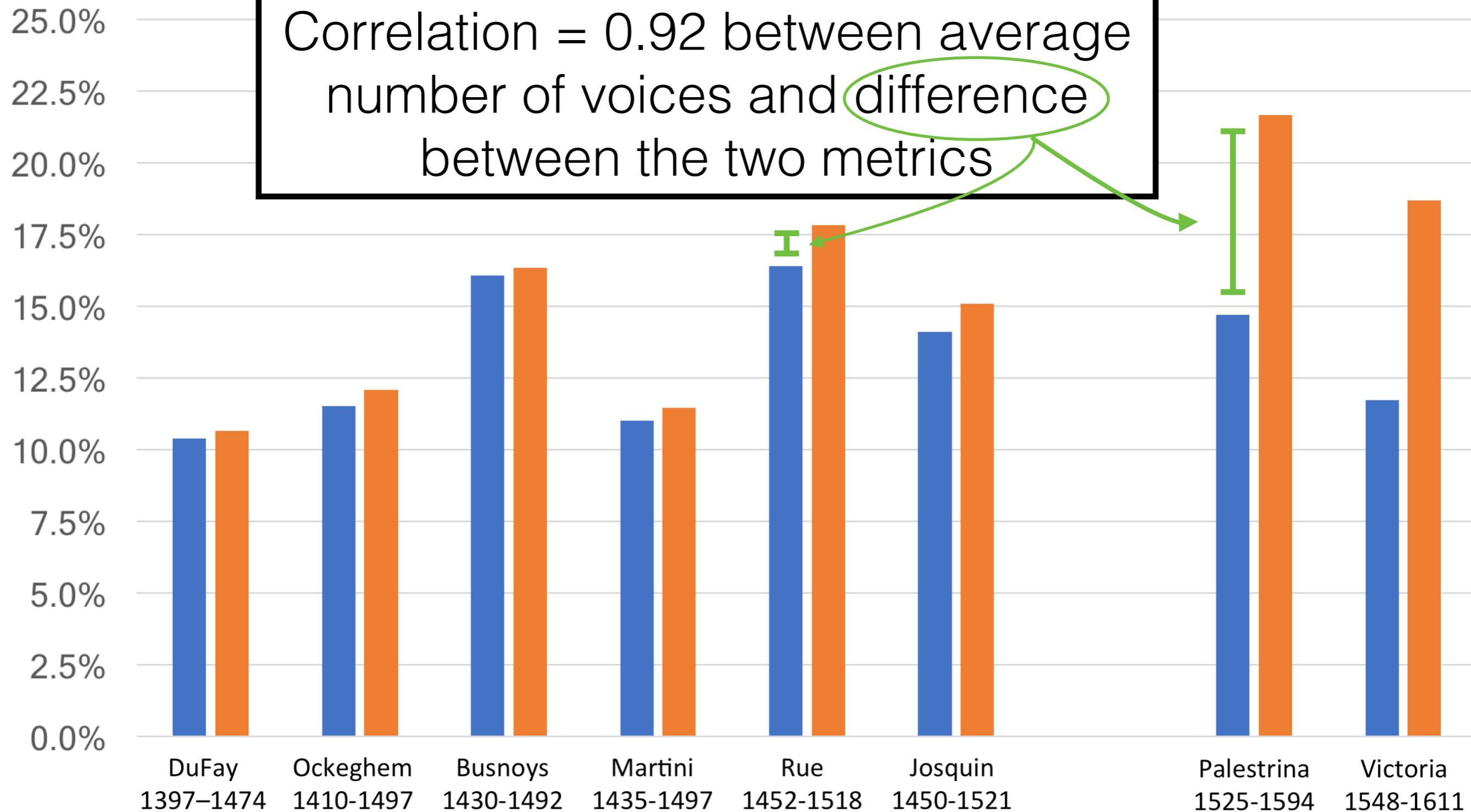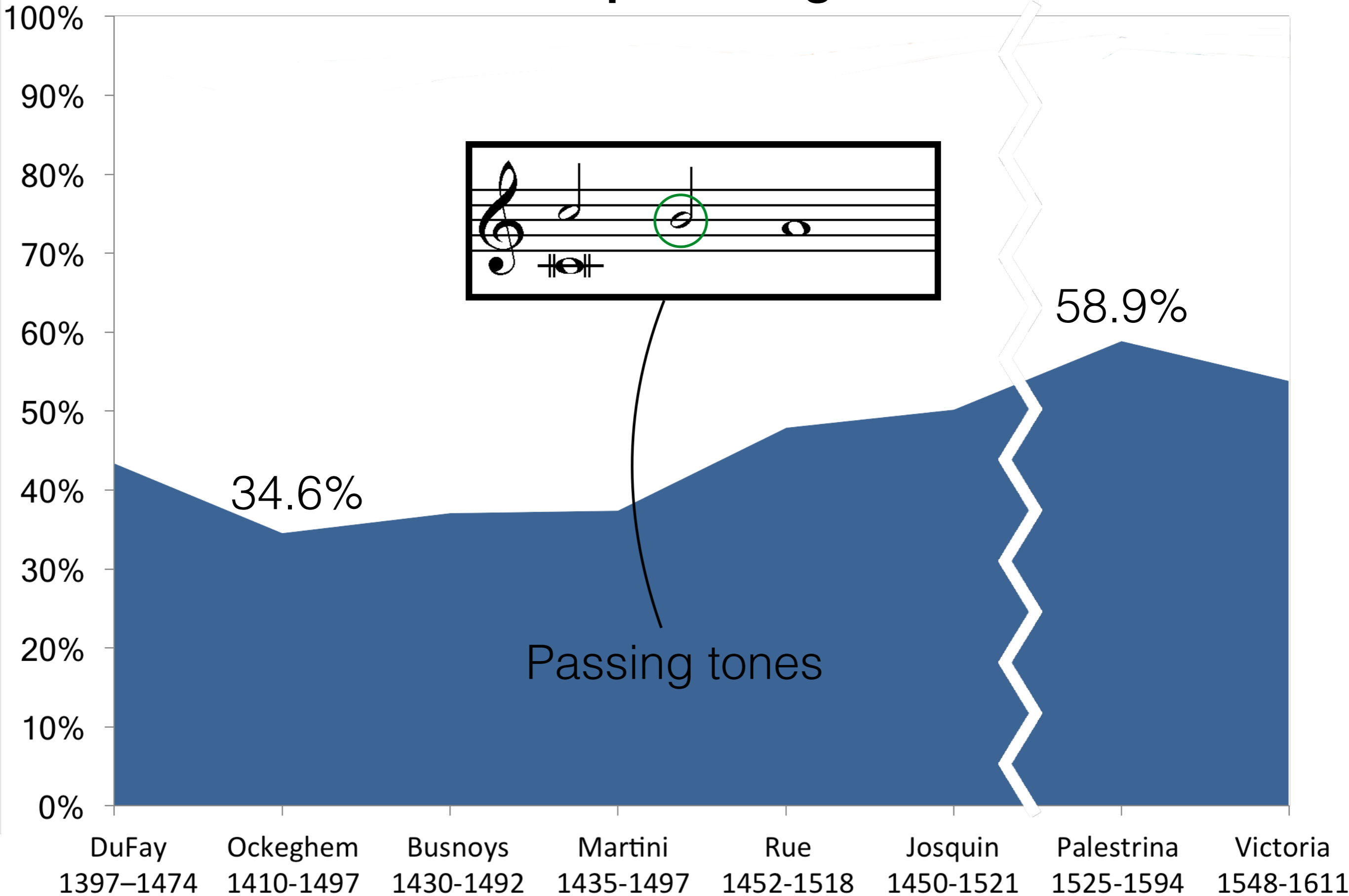
24

Percentage of
duration dissonant: 25%
Percentage of
dissonant notes: 25%

Percentage of
duration dissonant: 25%
Percentage of
dissonant notes: 20%

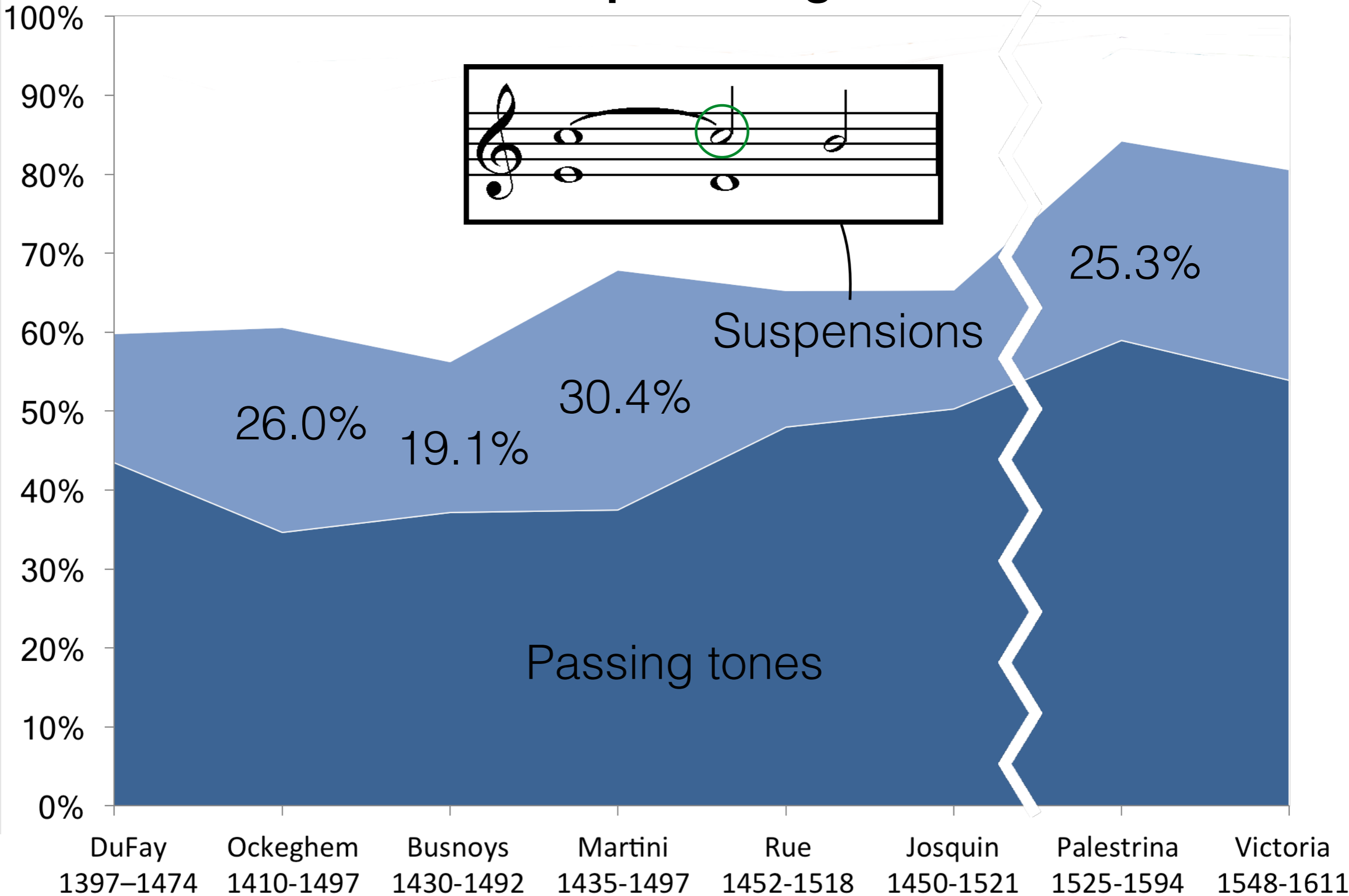Dissonant idioms as a percentage of all dissonance

proportion of dissonant notes stays fairly constant between the different composers, this would not meaningfully affect our results.

Consider passing tones, the most common dissonant idiom in the work of every composer in the corpus. At their least common, in Ockeghem, they nevertheless account for over one in every three dissonances, but they increase nearly two-fold to almost 60% of dissonances in Palestrina. Suspensions are the next most common dissonant idiom [SLIDE 27], and their usage remains relatively flat over the period in question, constituting, for instance, 26% of Ockeghem's dissonance and 25% of Palestrina's. On the other hand, the use of suspensions varies more between individual composers, being 30% of Martini's dissonance, for example, but only 19% of his contemporary Busnoy's.
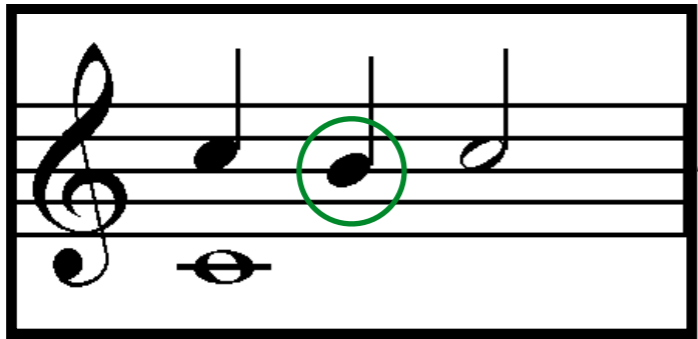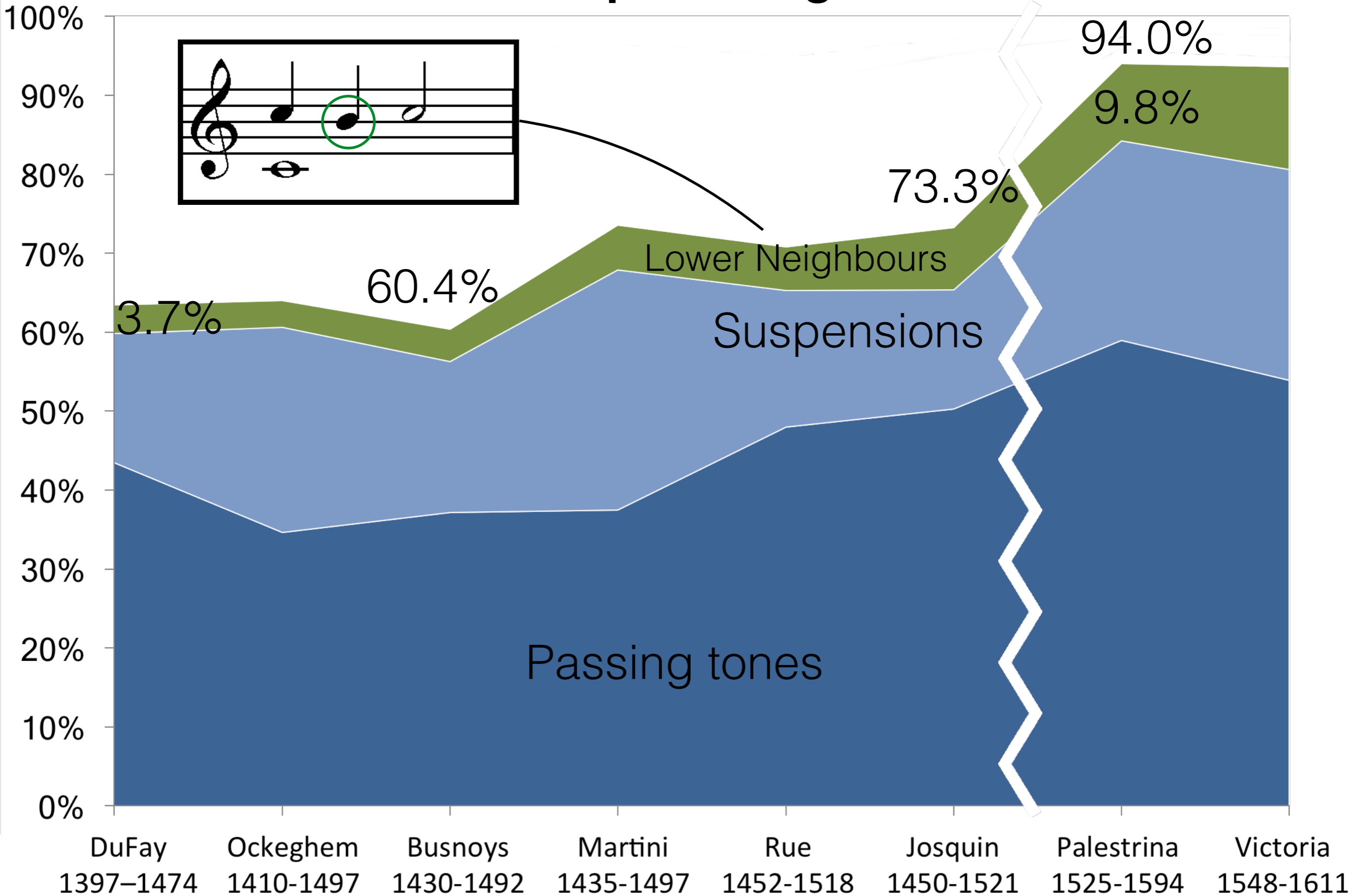
Note that with just these two dissonant idioms, passing tone and suspension, we have already accounted for over 50% of the dissonance treatment of every composer shown in this chart, and indeed, for every composer in our corpus. In fact, just these two idioms account for well over 80% of Palestrina's dissonance usage. In contrast, they make up only 56% of Busnoy's dissonance, and a similar proportion of that of his contemporaries. This contrast becomes still more impressive if we include one further dissonant idiom, the lower neighbour [SLIDE 28]. Lower neighbours increase in frequency from under 4% of dissonance in DuFay to 10% in Palestrina. With just these three idioms, then, we have now accounted for a remarkable 94% of Palestrina's dissonance, but a mere 60% of Busnoys's, and an intermediate 73% of Josquin's.

Since far more dissonance treatment remains to be accounted for in the earlier composers, it is clear that other dissonant idioms must necessarily become less common. One such idiom is what Peter Schubert has called the "legal dissonant third quarter," [SLIDE 29] a descending quarter-note passing tone that metrically falls on a weak half-note. It's prevalence hovered around

Dissonant idioms as a percentage of all dissonance

26.0%

19.1%

30.4%

Suspensions

25.3%

Passing tones

| DuFay 1397–1474 | Ockeghem 1410-1497 | Busnoys 1430-1492 | Martini 1435-1497 | Rue 1452-1518 | Josquin 1450-1521 | Palestrina 1525-1594 | Victoria 1548-1611 |

27

Dissonant idioms as a percentage of all dissonance

Dissonant idioms as a percentage of all dissonance

3.4%   15.2%   10.5%   1.9%   0.6%

Dissonant Third Quarter

Lower Neighbours

Suspensions

Passing tones

DuFay 1397–1474	Ockeghem 1410-1497	Busnoys 1430-1492	Martini 1435-1497	Rue 1452-1518	Josquin 1450-1521	Palestrina 1525-1594	Victoria 1548-1611

29
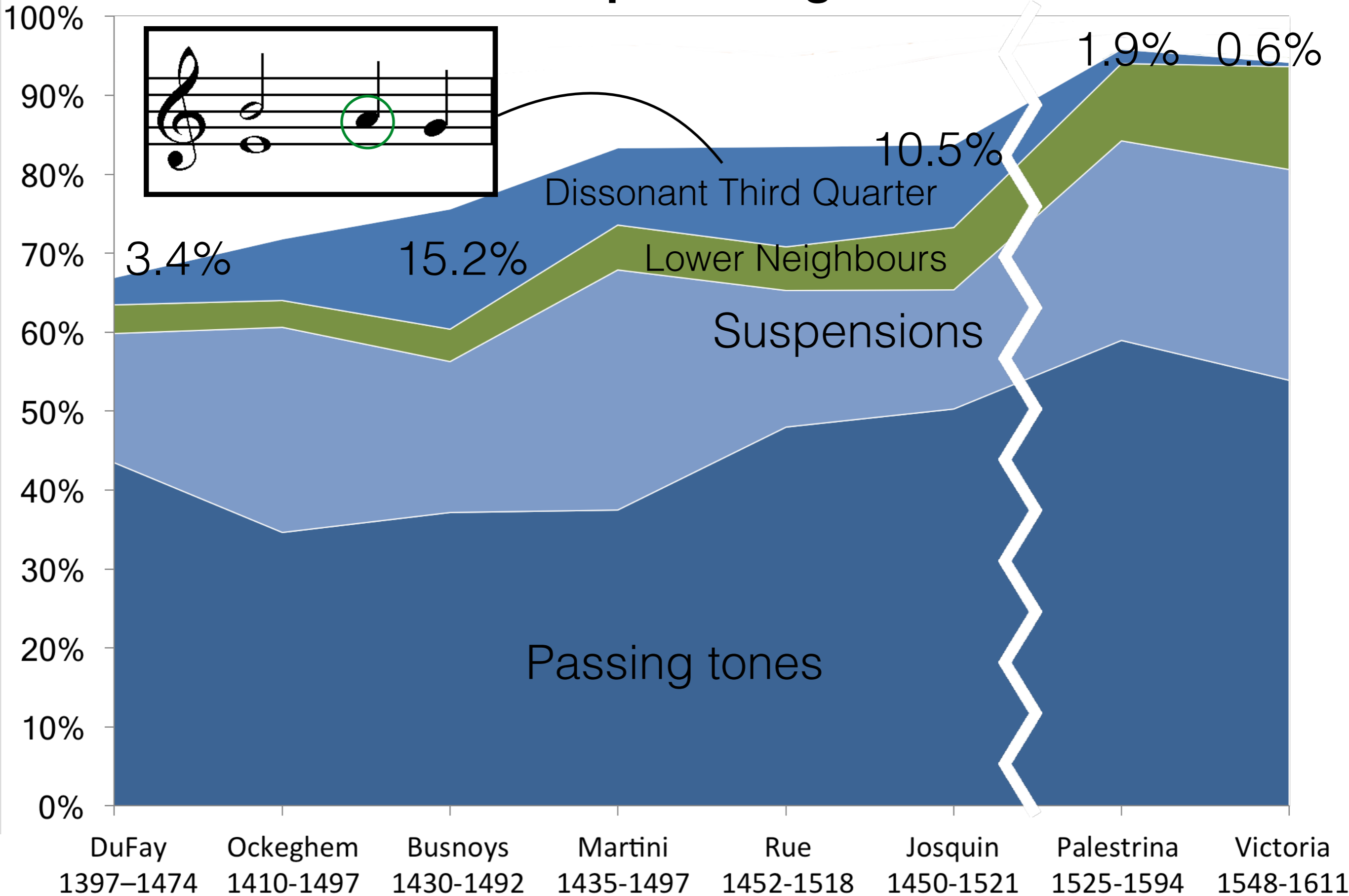
10% for most of the period under study—for instance, 10% in Josquin and 15% in Busnoys —but descended to 1.9% in Palestrina and a mere 0.6% in Victoria. Nevertheless, we shouldn't get the impression that its usage follows a uniform descent, as though pulled down by some inexorable force: before its rise in the music of Josquin and friends, this idiom constituted a mere 3% of the dissonances used by DuFay, the earliest composer in the corpus. A uniform descent *is* exhibited, on the other hand, in the case of the échappée [SLIDE 30], which in DuFay's music is the third most common dissonant idiom, at over 11% of dissonance ; by Josquin, échappée usage has declined to 2.4% and would eventually descend to less than 0.1% of Palestrina's dissonance. Observe that the incomplete (or three-note) cambiata [SLIDE 31], underwent a similar evolution, from an important element of the contrapuntal toolkit to essentially absent in the works of Palestrina and Victoria. In this connection, it is interesting to observe that the incomplete cambiata is conceptually similar to the échappée. Both involve a dissonance approached by step and left by leap. Moreover, in either case, the implied resolution of the dissonant note is left incomplete. To see what we mean, compare the four-note- or "complete" cambiata [SLIDE 32]: here, although the dissonant pitch is still leapt from, it is given a delayed melodic resolution by the fourth note, which completes the stepwise descent that the dissonant pitch might have been expected to have begun. According to Jeppesen, it is this resolution that makes the complete cambiata idiom acceptable in Palestrina style, and indeed, while the usage of the complete cambiata declines threefold from DuFay to Palestrina, this is far less steep than the sixty-fold decline in the use of the incomplete cambiata.

Most of the remaining idioms, [SLIDE 33] which include anticipations, upper neighbour notes, and retardations, occupy shrinking portions of the dissonant landscape. In sum, a clear story emerges about dissonance treatment over this period, which we might summarize as "the

Dissonant idioms as a percentage of all dissonance
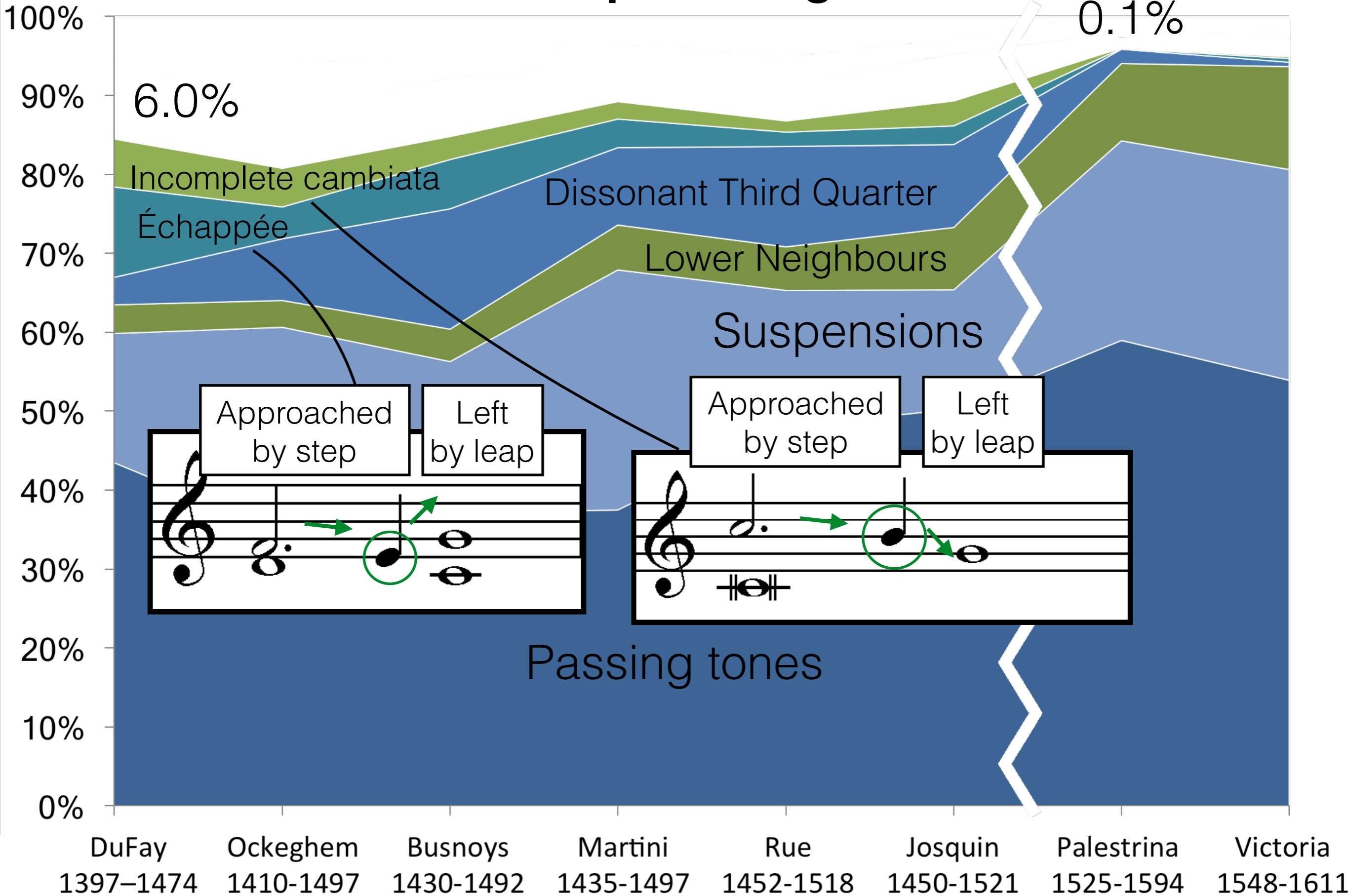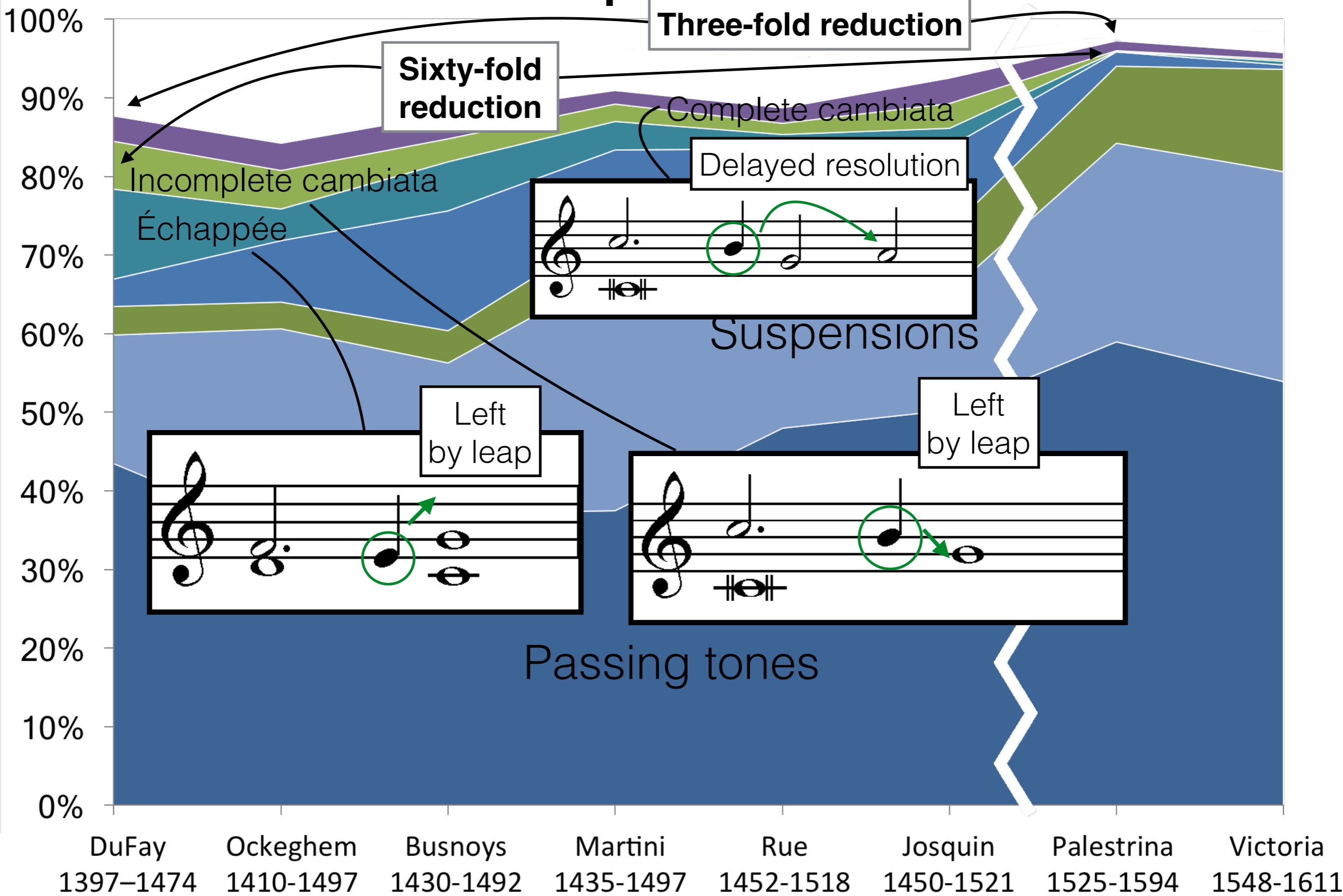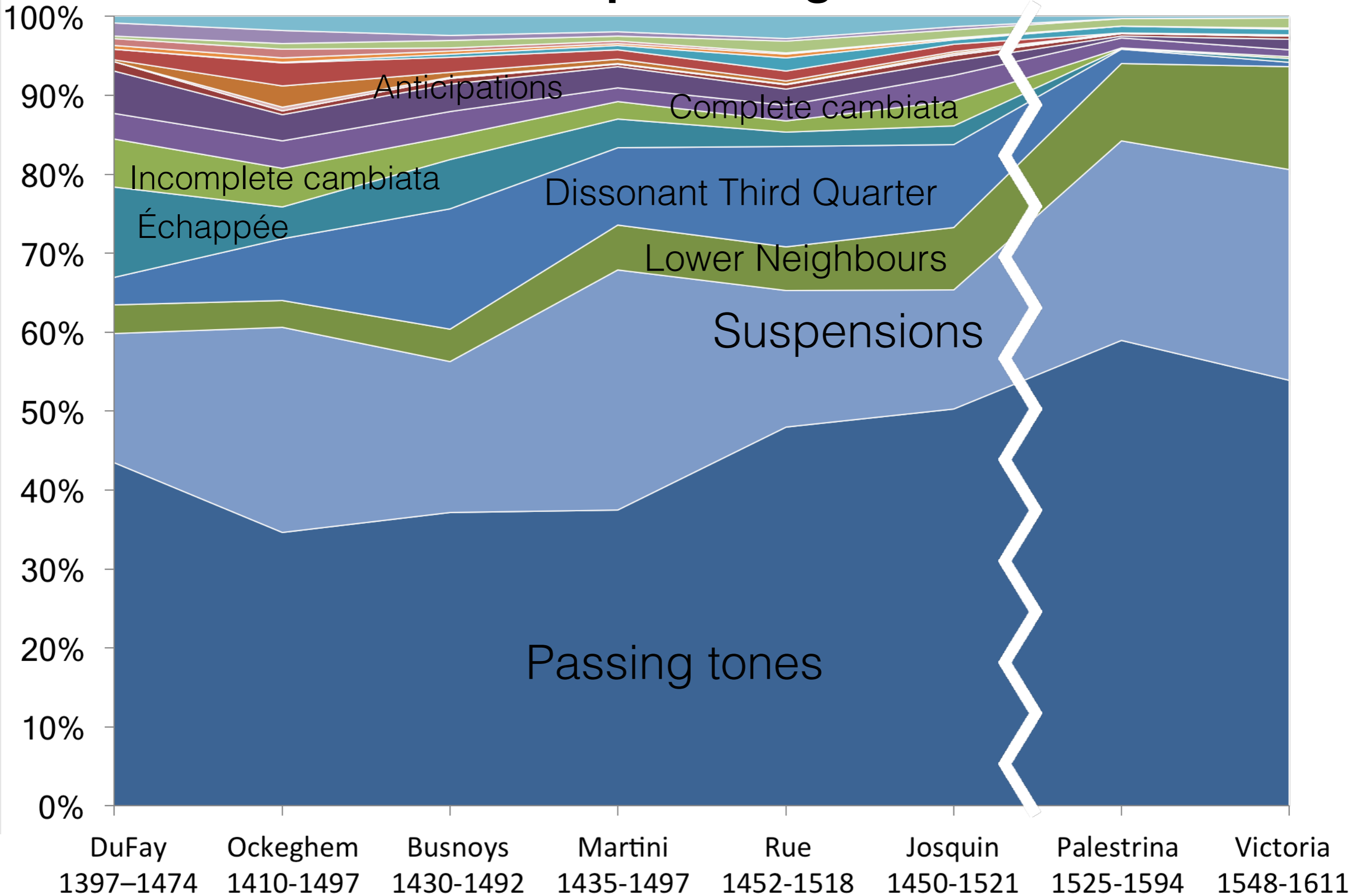
30

Dissonant idioms as a percentage of all dissonance

0.1%

6.0%

Incomplete cambiata

Échappée

Dissonant Third Quarter

Lower Neighbours

Suspensions

| Approached by step | Left by leap |

Passing tones

| Approached by step | Left by leap |

DuFay 1397–1474 · Ockeghem 1410-1497 · Busnoys 1430-1492 · Martini 1435-1497 · Rue 1452-1518 · Josquin 1450-1521 · Palestrina 1525-1594 · Victoria 1548-1611

Dissonant idioms as a percentage of all dissonance

Dissonant idioms as a percentage of all dissonance

Anticipations

Complete cambiata

Incomplete cambiata

Dissonant Third Quarter

Échappée

Lower Neighbours

Suspensions

Passing tones

DuFay 1397–1474	Ockeghem 1410-1497	Busnoys 1430-1492	Martini 1435-1497	Rue 1452-1518	Josquin 1450-1521	Palestrina 1525-1594	Victoria 1548-1611

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rich get richer": the "most common" idioms, such as passing tones and suspensions, already enjoyed most of the "dissonance pie", but they went on to enjoy virtually *all* of the pie, became very nearly the "only acceptable" idioms.

[SLIDE 34] Another way we might tell this same story is by comparing the ratio of the descending and ascending versions of the various idioms. (Please note that this chart is on a logarithmic axis, so each successive line is ten times greater than the previous line.) For example, when, in the corpus as a whole, we examine the ratio of descending and ascending suspensions (the latter better known as retardations, as we have seen), we discover that suspensions are over 160 times more likely to descend than to ascend. If, however, we separate our corpus into the Josquin Research Project [SLIDE 35] and the music of Palestrina and Victoria, we find another instance of the rich getting richer : suspensions go from about 80 times more likely to descend to 5500 times more likely to descend. The situation is similar with neighbour notes, legal dissonant third quarters, and échappées: [SLIDE 36] in all the music under consideration, each is much more common in its descending form, and yet this asymmetry becomes far more pronounced in the later repertoire. What of the cambiata? An ascending form of cambiata was used by composers such as Josquin and Ockeghem, always in a "complete" four-note form, and it was outnumbered forty-five to one by descending cambiatas. This ascending cambiata then vanishes entirely in Palestrina and Victoria, where the ratio of descending to ascending cambiatas therefore becomes infinite (regrettably SMT was unable to provide us with a projector screen adequate to display this complete chart). Uniquely among these idioms, passing tones are used about as often in ascending as in descending form, and are therefore almost invisible on this chart [SLIDE 37]. Nevertheless, if we zoom in, we can see that the asymmetry, though small, becomes much larger in Palestrina and Victoria.
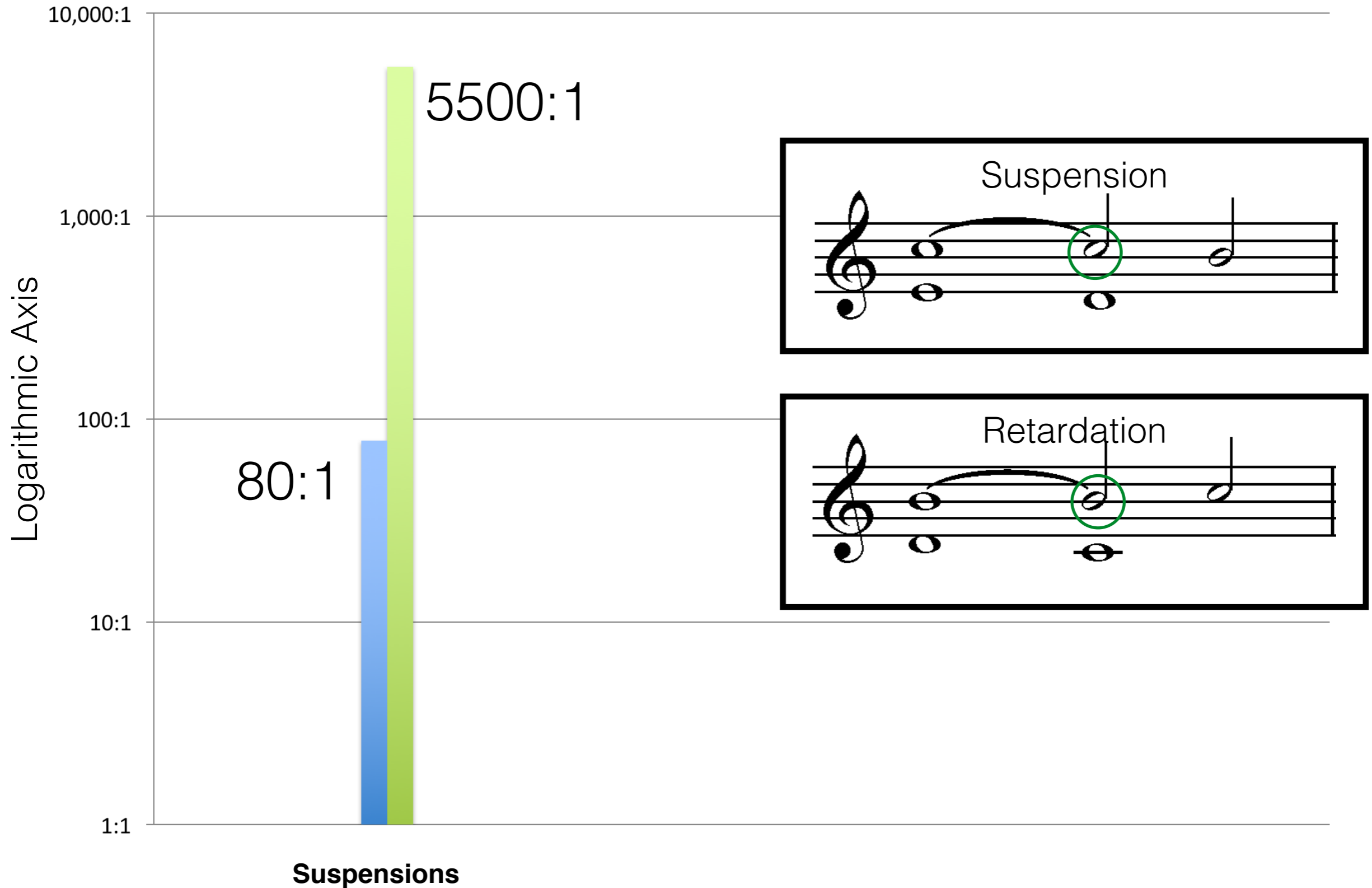
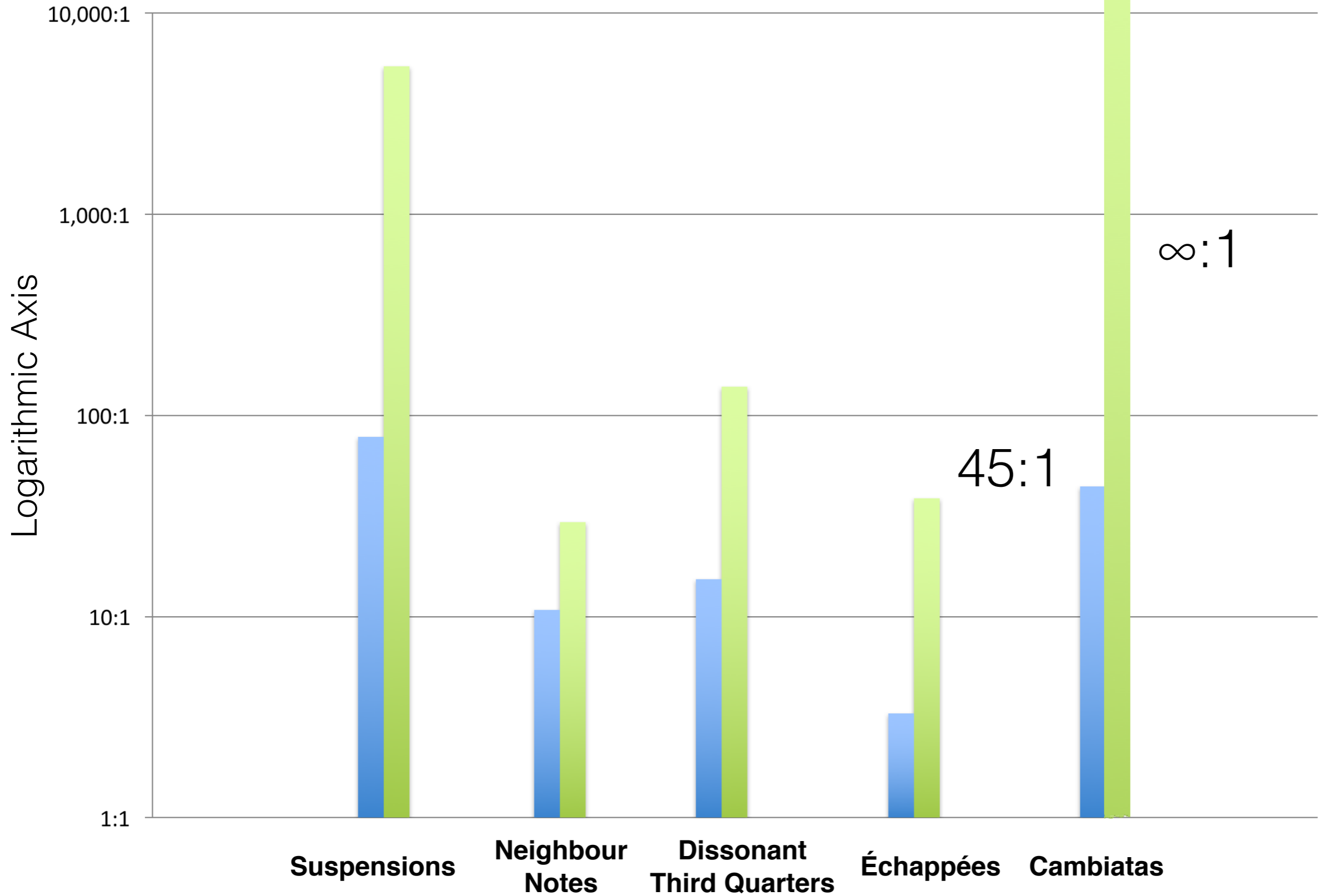# Ratio of descending to ascending dissonant idioms

■ **Entire corpus**

10,000:1

Logarithmic Axis

1,000:1

160:1

100:1

10:1

1:1

Suspensions

Suspension

Retardation
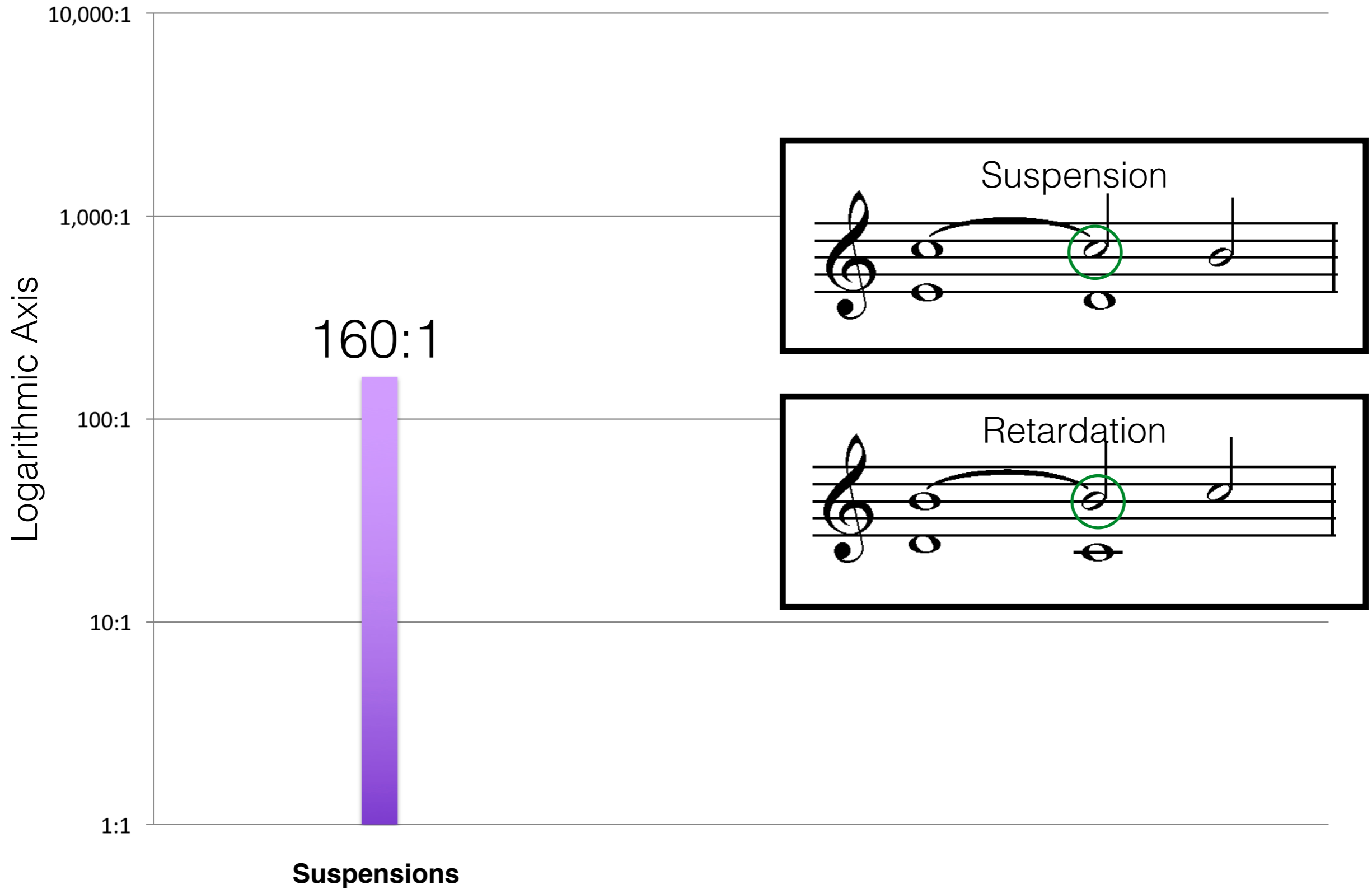
Ratio of descending to ascending dissonant idioms

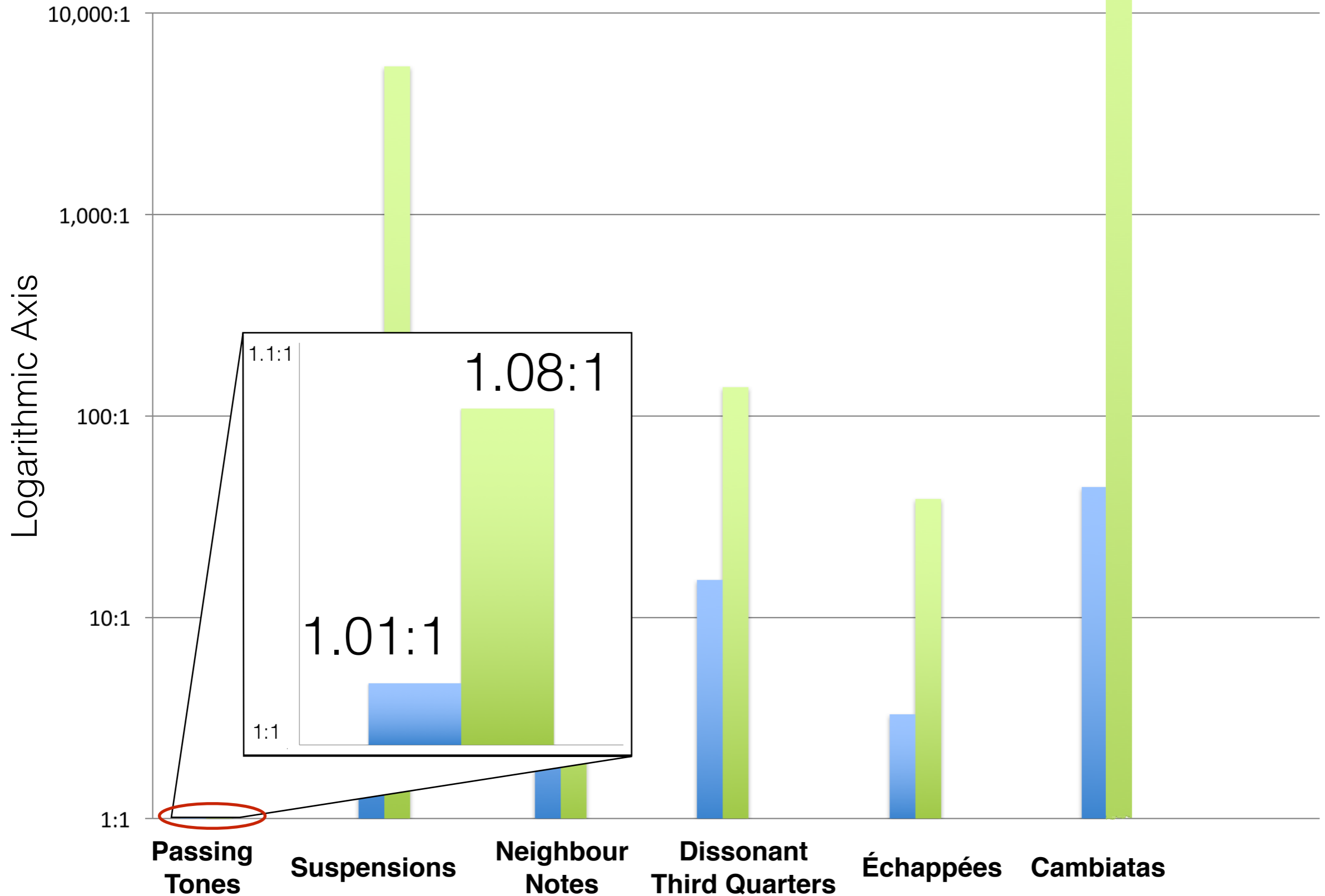**Entire corpus** **Josquin Research Project Only** **Palestrina and Victoria Only**

5500:1

80:1

Suspension

Retardation

Logarithmic Axis

10,000:1

1,000:1

100:1

10:1

1:1

Suspensions

Ratio of descending to ascending dissonant idioms

Legend:
- Entire corpus (purple)
- Josquin Research Project Only (blue)
- Palestrina and Victoria Only (green)

Y-axis: Logarithmic Axis (1:1, 10:1, 100:1, 1,000:1, 10,000:1)

X-axis categories: Suspensions, Neighbour Notes, Dissonant Third Quarters, Échappées, Cambiatas

Annotations: ∞:1, 45:1

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Ratio of descending to ascending dissonant idioms

But why should there be such a consistent asymmetry between descending and ascending dissonant idioms? We propose that we can make sense of this asymmetry by treating Renaissance composers as intuitive music psychologists, concerned to write dissonance that is inconspicuous. That Renaissance composers *were* concerned to write inconspicuous dissonance is suggested by the very sound of their music, and confirmed by the writings of major Renaissance theorists such as Tinctoris [SLIDE 38]—who insists that dissonances must not "represent themselves so vehemently to the hearing"—and Zarlino, who says that dissonance must leave the ear "not sufficiently stimulated" to "comprehend it fully." We can therefore assume that a dissonant idiom that is used more often is understood to be less salient, and the distribution of more and less common forms of dissonance, such as the asymmetries between descending and ascending forms of idioms that we have observed, can be seen as a set of hypotheses about the relative salience of different types of melodic contours. We will see that doing so will allow us add a nuance to our "rich get richer" story of dissonance treatment.

For instance, compare the passing tone [SLIDE 39] with the neighbour. The idioms are similar, metrically weak and both approached and left by step, but they differ in contour, and the passing tone is about six times as common as the neighbour. If we compare their differing contours, we observe that in the case of the neighbour note, the dissonant tone is a pivot tone, that is, the high or low tone at which a change in contour is effected, whereas the passing tone is a non-pivot tone, a mid-point on some larger contour. Since dissonances occur less often as pivot-tone neighbours than as non-pivot tone passing tones, the hypothesis implicit in Renaissance dissonance treatment is that changes of contour are more stressed than other notes. This same hypothesis has been suggested by modern perceptual research.

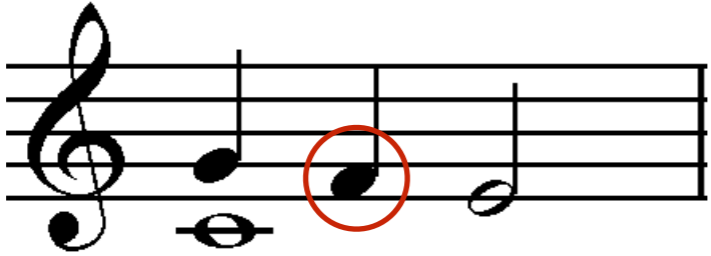Johannes Tinctoris, *Liber de arte contrapuncti*, 1477.
Dissonances must "not represent themselves so vehemently to the hearing."

Gioseffo Zarlino, *Le istitutioni harmoniche*, 1558.
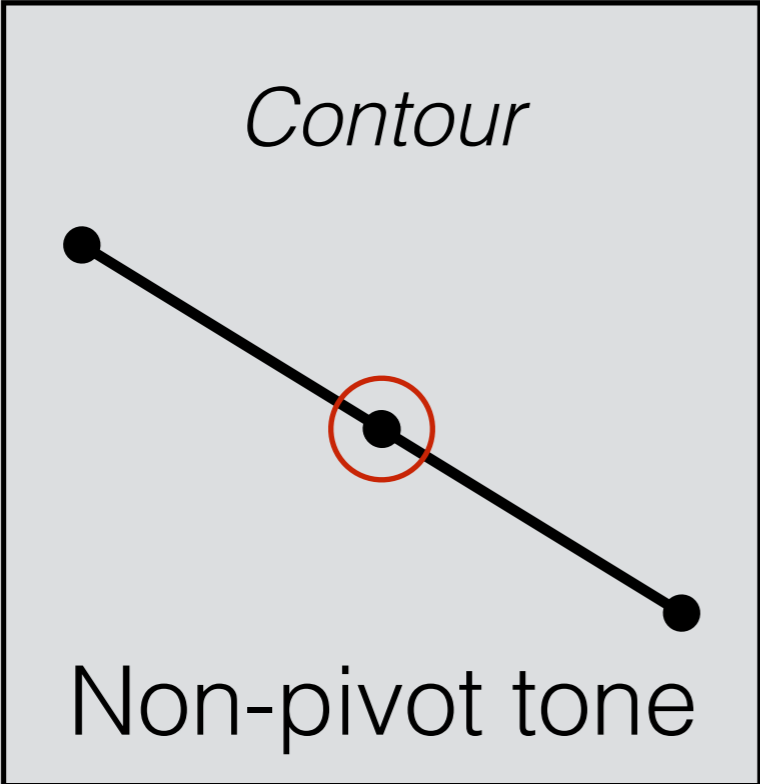*"The ear barely notices this dissonance, not being sufficiently stimulated by it to comprehend it fully."*

More common

Passing Tone

Contour

Non-pivot tone

Less common

Neighbour

6:1
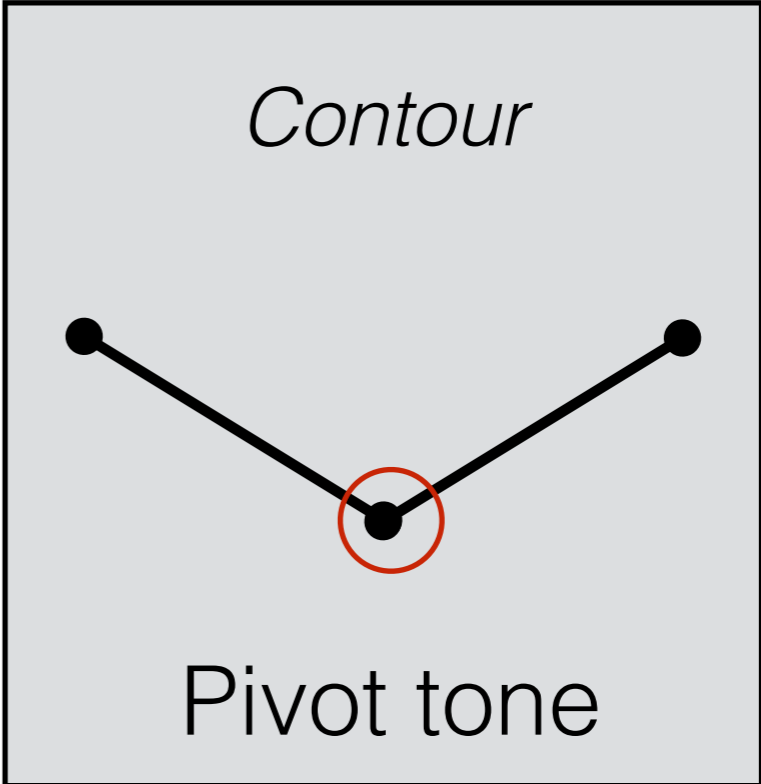
Contour

Pivot tone

Pivot tones are more stressed than non-pivot tones
(Thomassen 1982, Huron and Royal 1996)

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Returning now to the asymmetry between ascending and descending forms, we can compare, for instance, the lower neighbour [SLIDE 40] with the upper neighbour —the lower neighbour being about 17 times more common—or the descending échappée with the ascending échappée —the descending being about four times more common. We can observe that in the case of both idioms, in the descending form, the dissonant note forms a descending pivot tone, while in the ascending form, it forms an ascending pivot tone. The hypothesis implicit here is that ascending pivots are more perceptually prominent than descending pivots and, again, this hypothesis has also been suggested by modern research on perception.

A further hypothesis is suggested by comparing the cambiata [SLIDE 41] to the conceptually similar case where a note libre is approached and left in the same direction: if we examine their contours, neither involves a change of melodic direction or pivot tone, and both include a leap. However, in the case of the cambiata, the dissonance is leapt *from,* whereas in the case of the note libre, the dissonance is leapt *to.* In our corpus, the cambiata is 66 times as common as such similar-motion note libres. Such a predominance undoubtedly expresses a strong implicit hypothesis that notes *approached* by leap, as in the case of the note libre, are more perceptually prominent than notes *left* by leap, as in the case of the cambiata. As far as we know, there is no perceptual research addressing this particular comparison, but it could be a fruitful avenue for future study. Any greater stress upon leapt-to notes may simply result from the fact that leaps are harder to sing than steps. Whether or not such a perception of melodic accent is as strong for a passive listener as it is for an actively participating singer, it's perhaps worth noting that Renaissance composers undoubtedly all sang, and therefore conceived their music vocally, so it may in any case be more apposite in such repertoire to investigate perception from the perspective of the active participant.
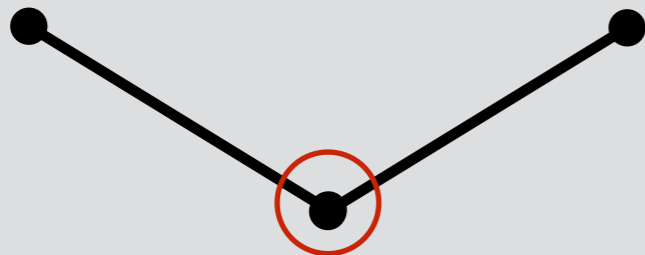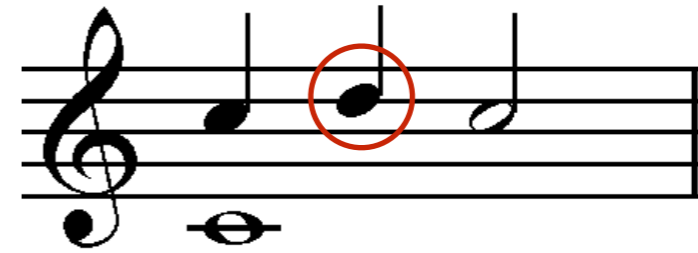
More common / Less common

Lower Neighbour — Upper Neighbour (17:1)

Descending Échappée — Ascending Échappée (3.5:1)
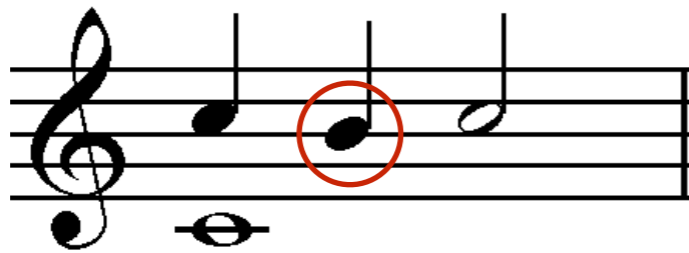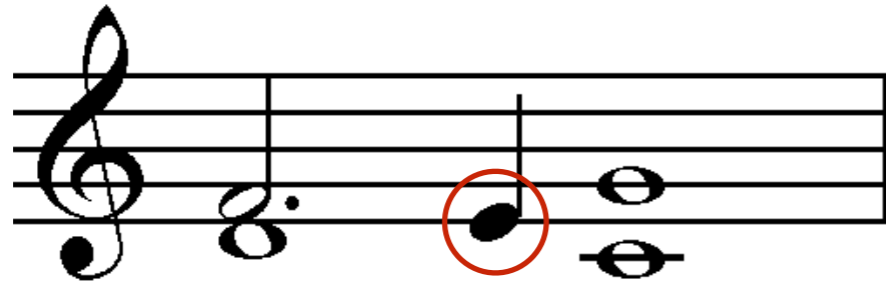
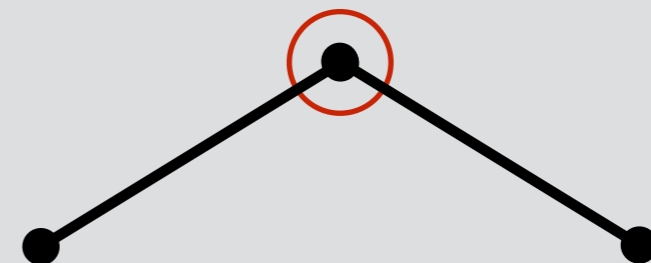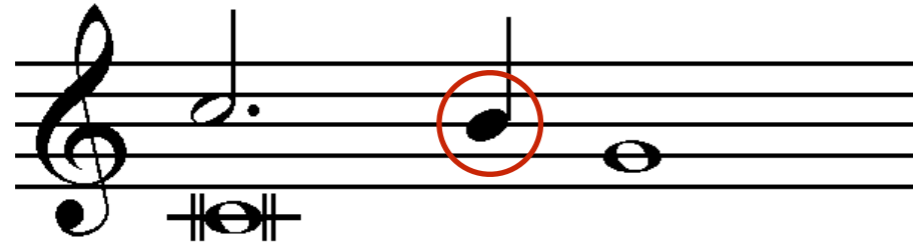Contour — Descending pivot
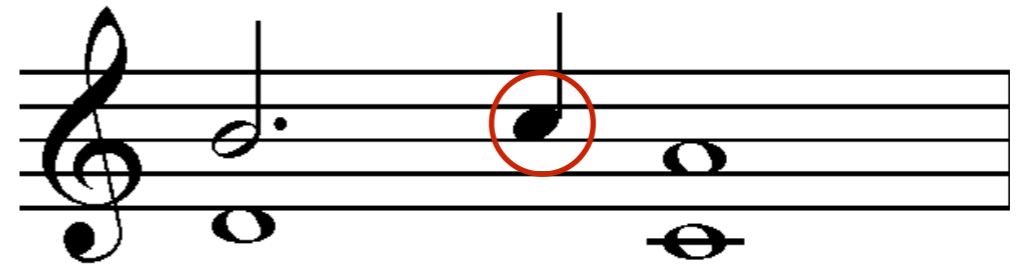
Contour — Ascending pivot

Ascending pivots more stressed than descending pivots
(Thomassen 1982, Huron and Royal 1996)
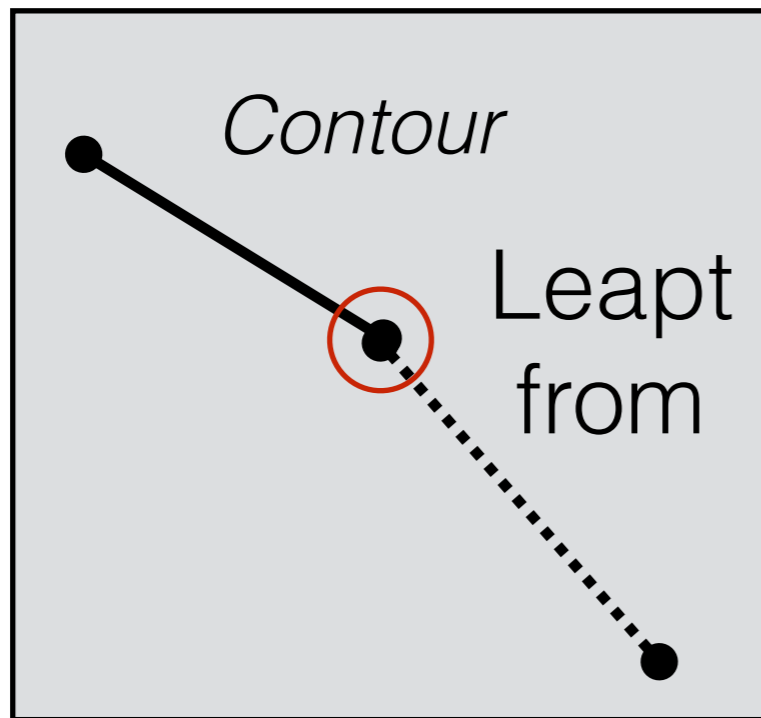
40

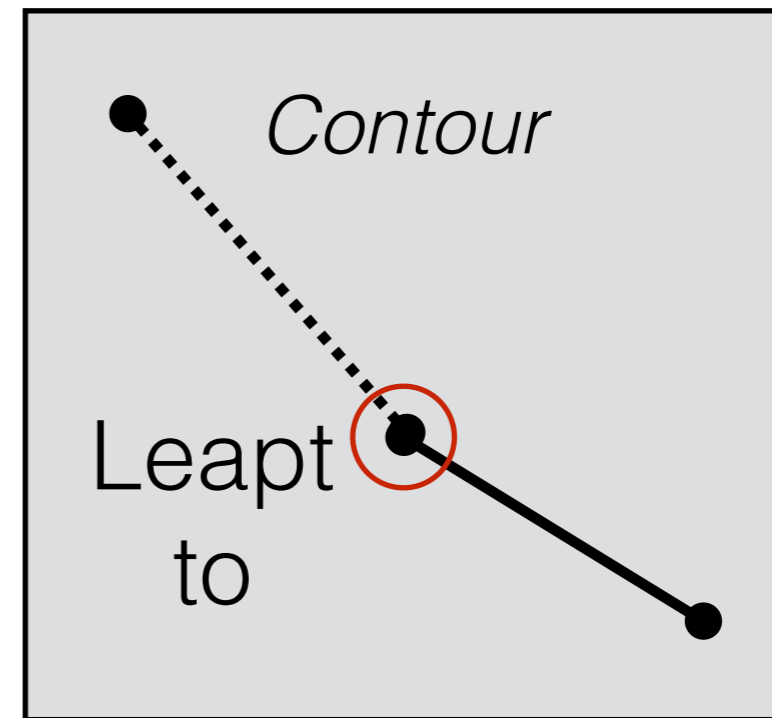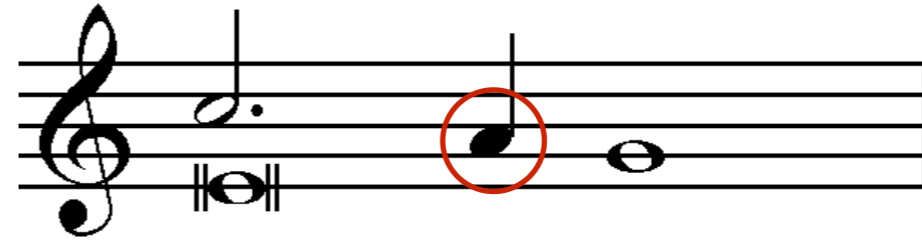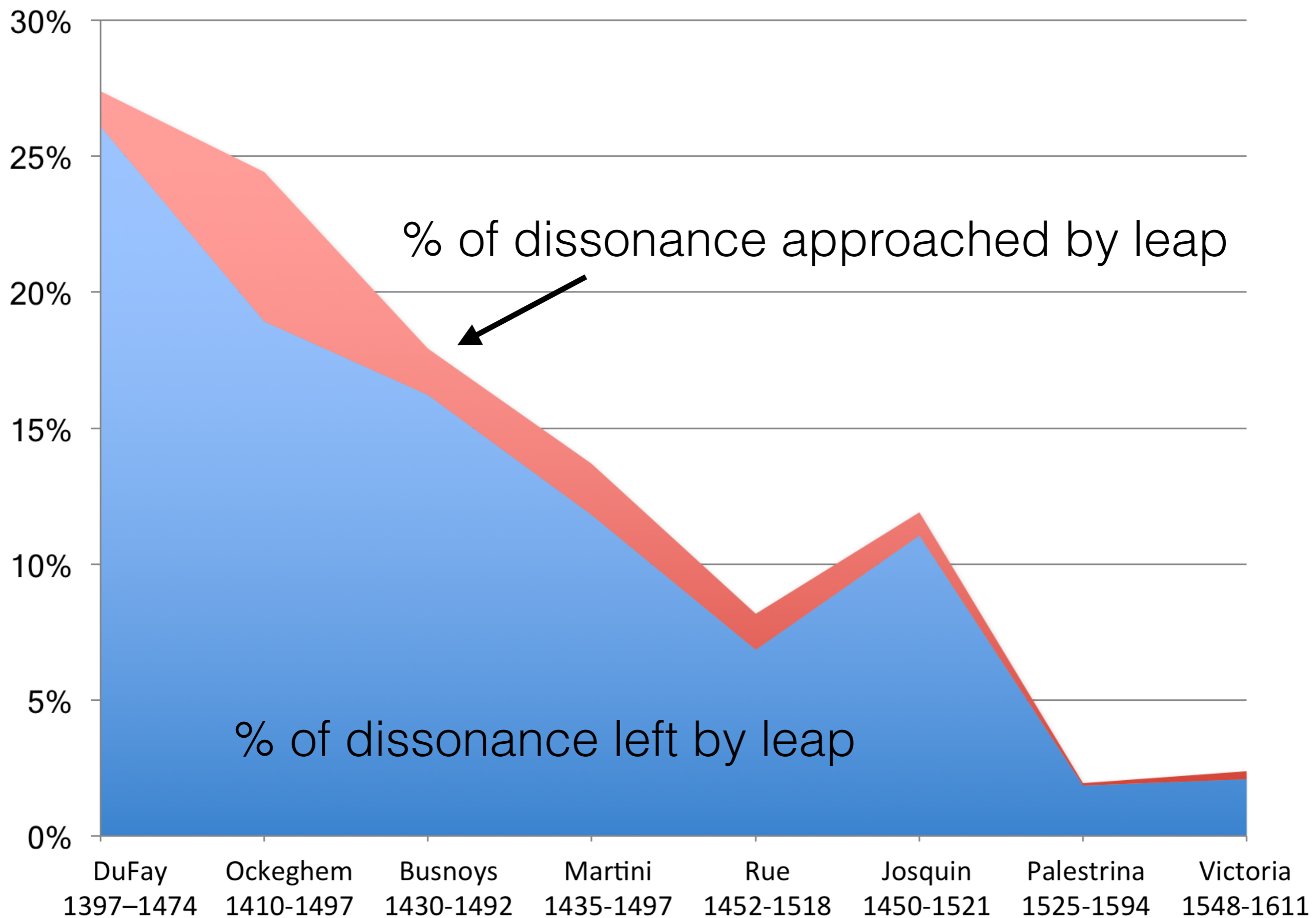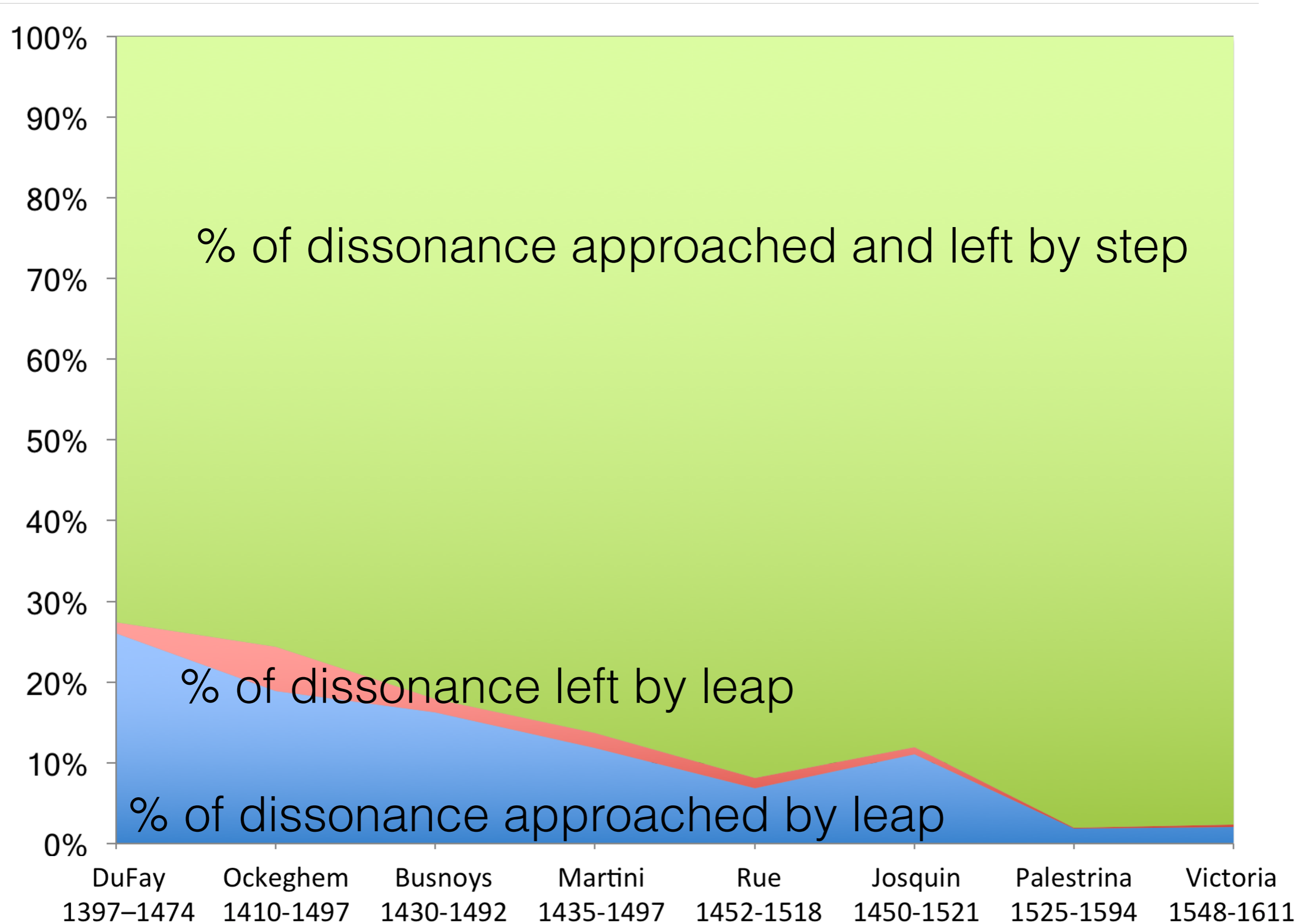Notes left by leap less prominent than notes approached by leap?

In any case, [SLIDE 42] throughout our corpus, dissonance *left* by leap is much more common than dissonance *approached* by leap, although all dissonances involving leaps become much less common as time goes on and, of course, throughout the period, [SLIDE 43] dissonance both approached and left by step is by far the most prevalent.

But returning to our comparison of cambiatas and notes libres [SLIDE 44], there is one remaining issue that we have not yet addressed. Dissonance left by leap may be less prominent than dissonance approached by leap, but doesn't it nevertheless pose a problem? Since a leap breaks the feeling of connection to the next note, doesn't it also sever the possibility for the dissonant note to be be satisfactorily *resolved* by the following note ?

To dig a little deeper into this question, let's compare the cambiata [SLIDE 45] with the lower neighbour. Looking at their contours, we observe that the neighbour is a pivot tone, while the cambiata is not. Since, as we've seen, pivot tones are more perceptually prominent, the dissonance of the cambiata should therefore be less prominent than the dissonance of the neighbour. However, the cambiata is left by leap, while the neighbour proceeds smoothly by step to the following note. Therefore, the dissonance of the cambiata is less successfully resolved than that of the neighbour. This poses a conundrum. What should a well-behaved Renaissance composer prefer: the cambiata, pleasingly non-prominent, but lamentably unresolved? or the lower neighbour, gratifyingly resolved, but disturbingly prominent? In fact, the preference of Renaissance composers shifted over time [SLIDE 46]. As you can observe, Cambiatas descended from 8.5% of DuFay's dissonance to about 1% of that of Palestrina and Victoria, whereas lower neighbours undergo the inverse progression, rising from 3% of DuFay to 10% of Palestrina and 13% of Victoria. While Cambiatas were about three times more common at the beginning of the period in question, by the end, lower neighbours were ten or more times more common.
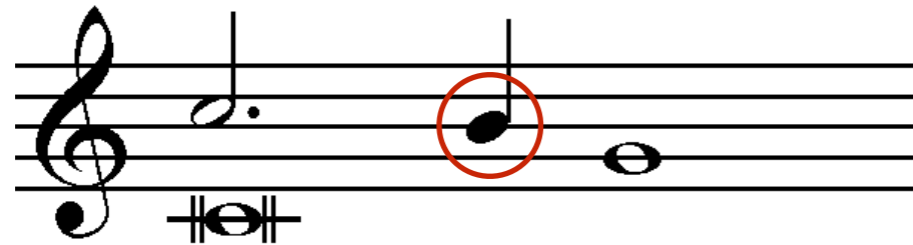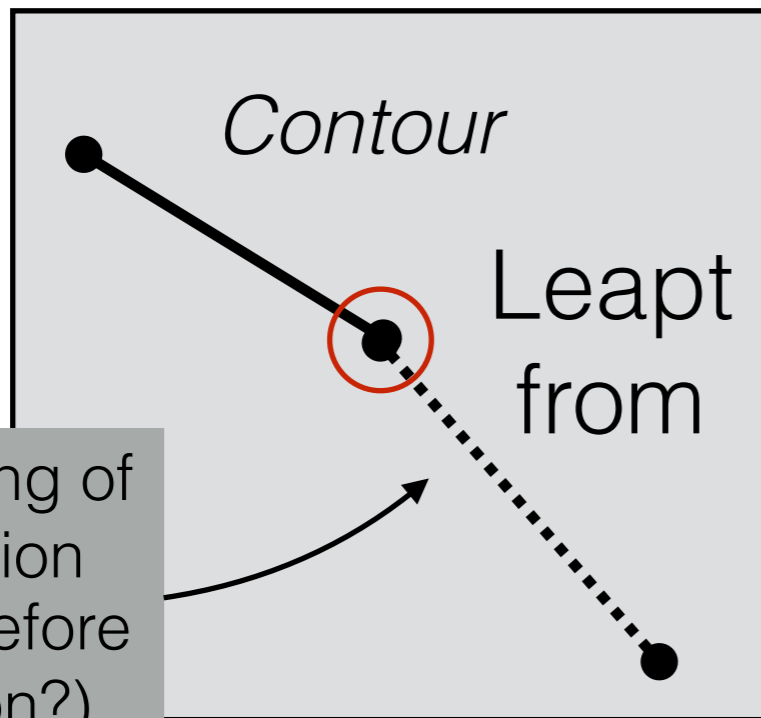
% of dissonance approached by leap

% of dissonance left by leap

| | DuFay 1397–1474 | Ockeghem 1410-1497 | Busnoys 1430-1492 | Martini 1435-1497 | Rue 1452-1518 | Josquin 1450-1521 | Palestrina 1525-1594 | Victoria 1548-1611 |

% of dissonance approached and left by step

% of dissonance left by leap

% of dissonance approached by leap

| | DuFay 1397–1474 | Ockeghem 1410-1497 | Busnoys 1430-1492 | Martini 1435-1497 | Rue 1452-1518 | Josquin 1450-1521 | Palestrina 1525-1594 | Victoria 1548-1611 |

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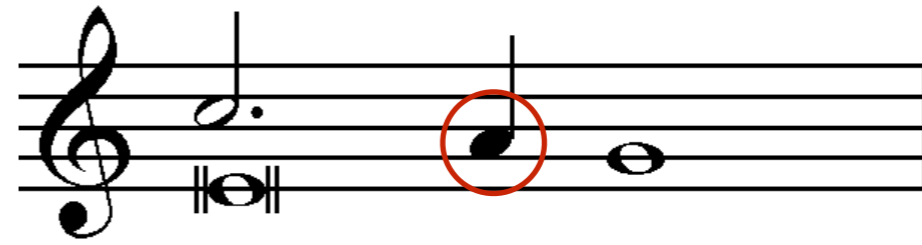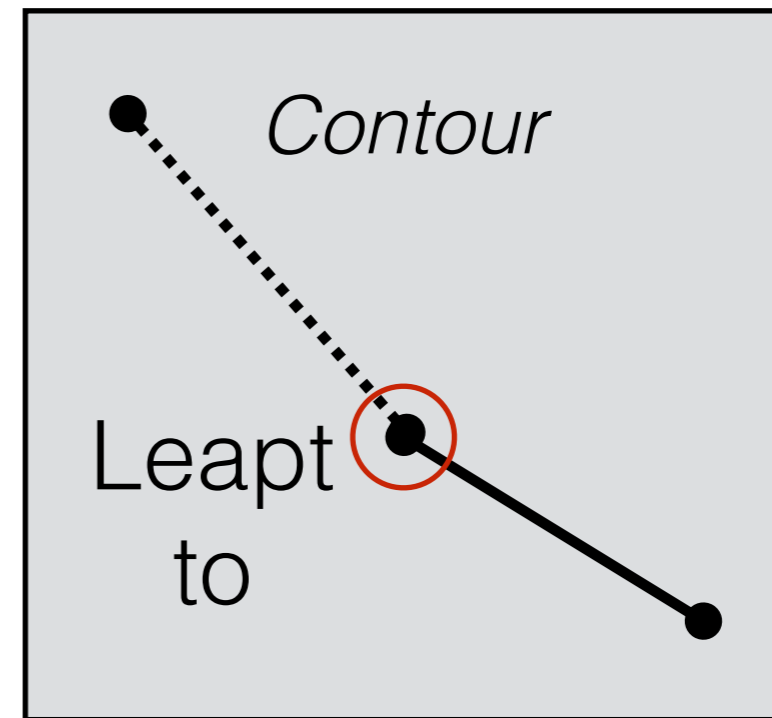
Notes left by leap less prominent than notes approached by leap?

Cambiata

Contour

Left by leap

No pivot tone

Lower Neighbour

Contour

Left by step

Pivot tone
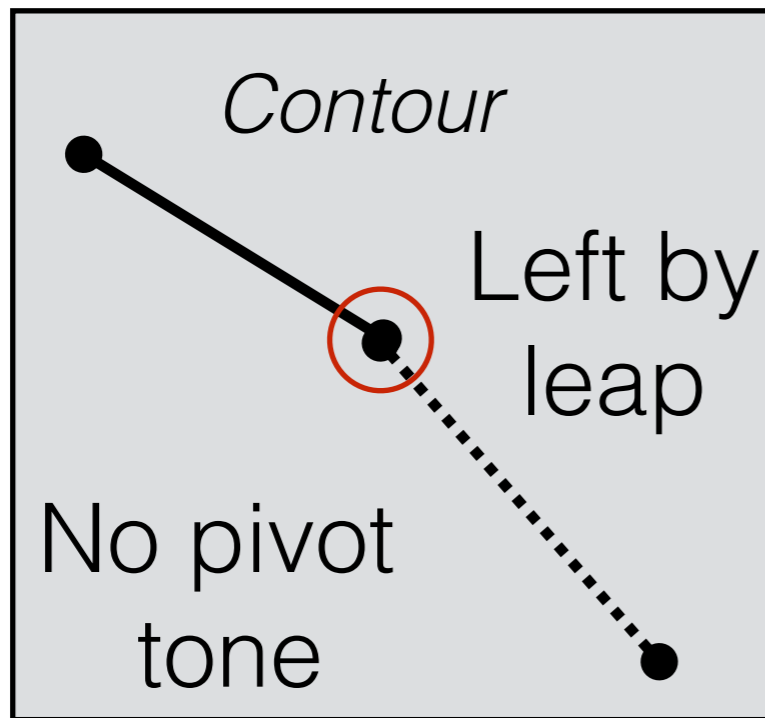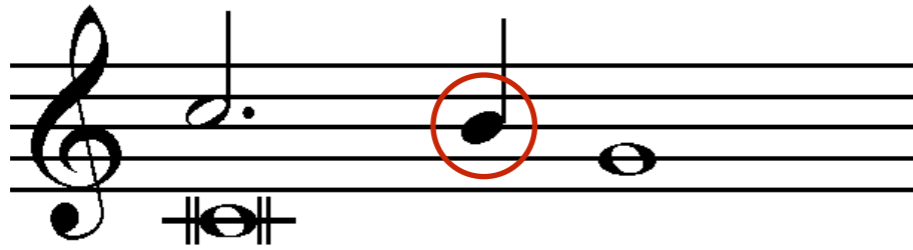
Dissonance less prominent   Dissonance more prominent
Dissonance less resolved   Dissonance more resolved

Cambiatas and Lower Neighbours
as a percentage of all dissonance

3 times more common

Cambiatas
(less prominent
but less resolved)

10+ times more common

Lower Neighbours
(more prominent
but more resolved)

8.5%

13%

10%

3%

~1%

| 14% |
| 12% |
| 10% |
| 8% |
| 6% |
| 4% |
| 2% |
| 0% |

| DuFay 1397–1474 | Ockeghem 1410-1497 | Busnoys 1430-1492 | Martini 1435-1497 | Rue 1452-1518 | Josquin 1450-1521 | Palestrina 1525-1594 | Victoria 1548-1611 |
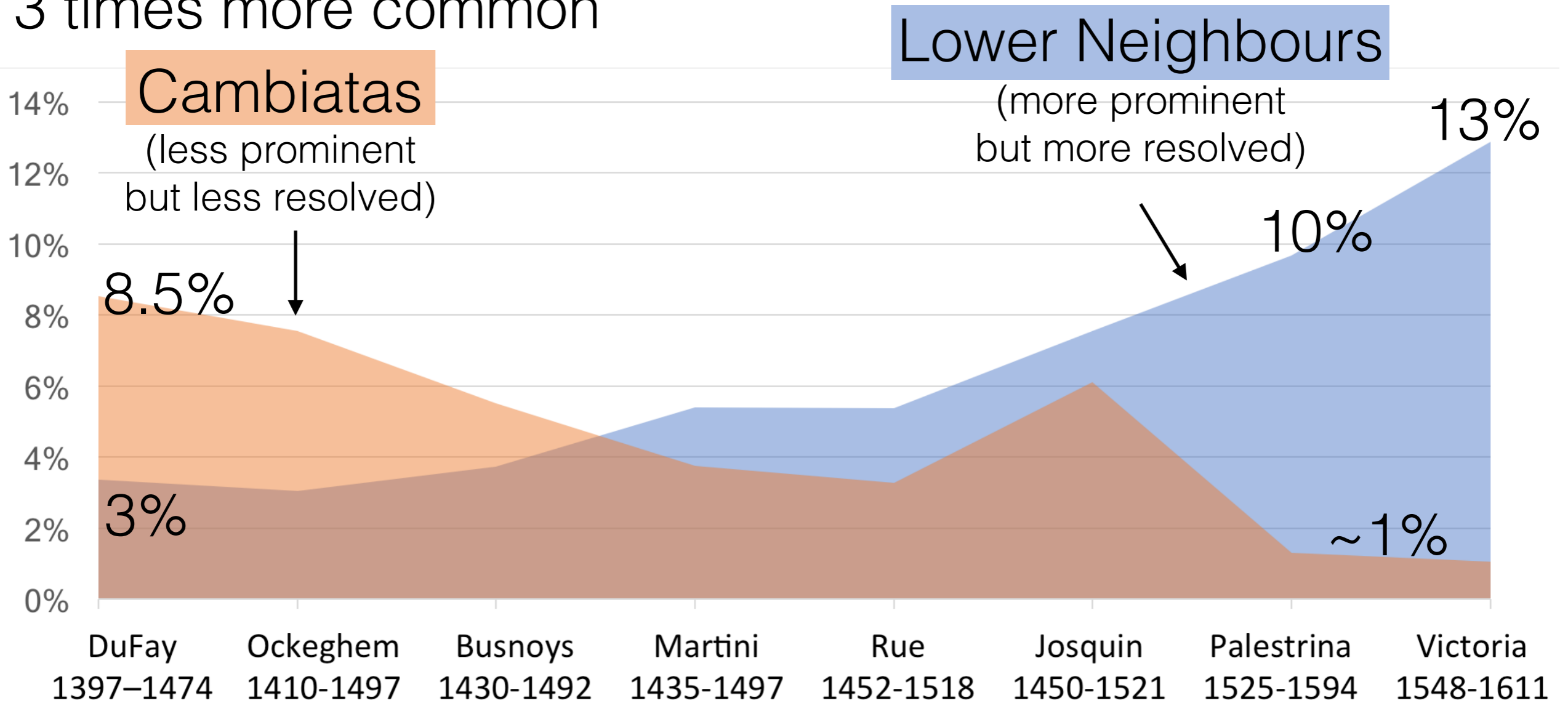
It appears, in sum, that at the opening of our historical window, simple non-prominence was the primary consideration in dissonance treatment, while by its close, *resolution* had joined and perhaps surpassed non-prominence as a key factor. In this connection, it is interesting to note that in the major treatise on counterpoint written during the period of the music of the Josquin Research Project, Tinctoris's 1477 *Liber de arte contrapuncti* [SLIDE 47], the word "resolution," or any synonym for it, is conspicuously absent. For Tinctoris, dissonance is nothing more than a necessary evil, since music "cannot occasionally be made without discords." He mocks the idea that dissonance can make a following consonance more "suave" with the ironic metaphor that "[n]ever ought any vice be committed by a man of commendable virtue so that his virtue may shine more clearly." In contrast, Zarlino, the major theorist of the time of Palestrina, not only mentions resolution, but goes on to say that well-treated dissonance "is very agreeable to the ear, for the dissonance makes the consonance seem sweeter and smoother."

[SLIDE 48] We would like to close by proposing that these observations suggest a modification of the commonplace story of the evolution of Renaissance dissonance treatment. It is not so much that dissonance became more "controlled" through the use of a smaller number of dissonant idioms—indeed, it seems silly to imagine that Josquin and DuFay were trying not to write incomplete cambiatas but nevertheless kept accidentally doing so. Nor was it that dissonance was simply "reduced," since the overall amount of dissonance stayed flat or even increased, as we have seen. It was, rather, that *resolution* of dissonance took on new importance. It may be this that allowed dissonance to then play a more syntactic role in future styles of music, and which made it possible, well after the music of Palestrina and Victoria, for something we might call a "first emancipation of the dissonance" to take place: namely, for perceptually prominent dissonance to be deliberately used as an expressive device, as in the seventh chords,

Johannes Tinctoris, *Liber de arte contrapuncti*, 1477.
- does not speak of resolution
- dissonance cannot make a following consonance more "suave":

    "Never ought any vice be committed by a man of commendable virtue so that his virtue may shine more clearly"

Gioseffo Zarlino, *Le istitutioni harmoniche*, 1558.
- does speak of resolution
- well-treated dissonance can please:

    "Not only does this dissonance not displease, but it is very agreeable to the ear, for the dissonance makes the consonance seem sweeter and smoother."

Conclusion

diminished seventh chords, and unprepared appoggiature that we find throughout the common-practice tonal repertoire.

[SLIDE 49] Thank you.

Thanks to:
Jon Wild, Eliot Handelman, Peter Schubert, Stephen McAdams, Albert Bregman, Marie-Ève Piché;
Ichiro Fujinaga, Julie Cumming, Claire Arthur, and SIMSSA;
Jesse Rodin, Craig Sapp and the
Josquin Research Project

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