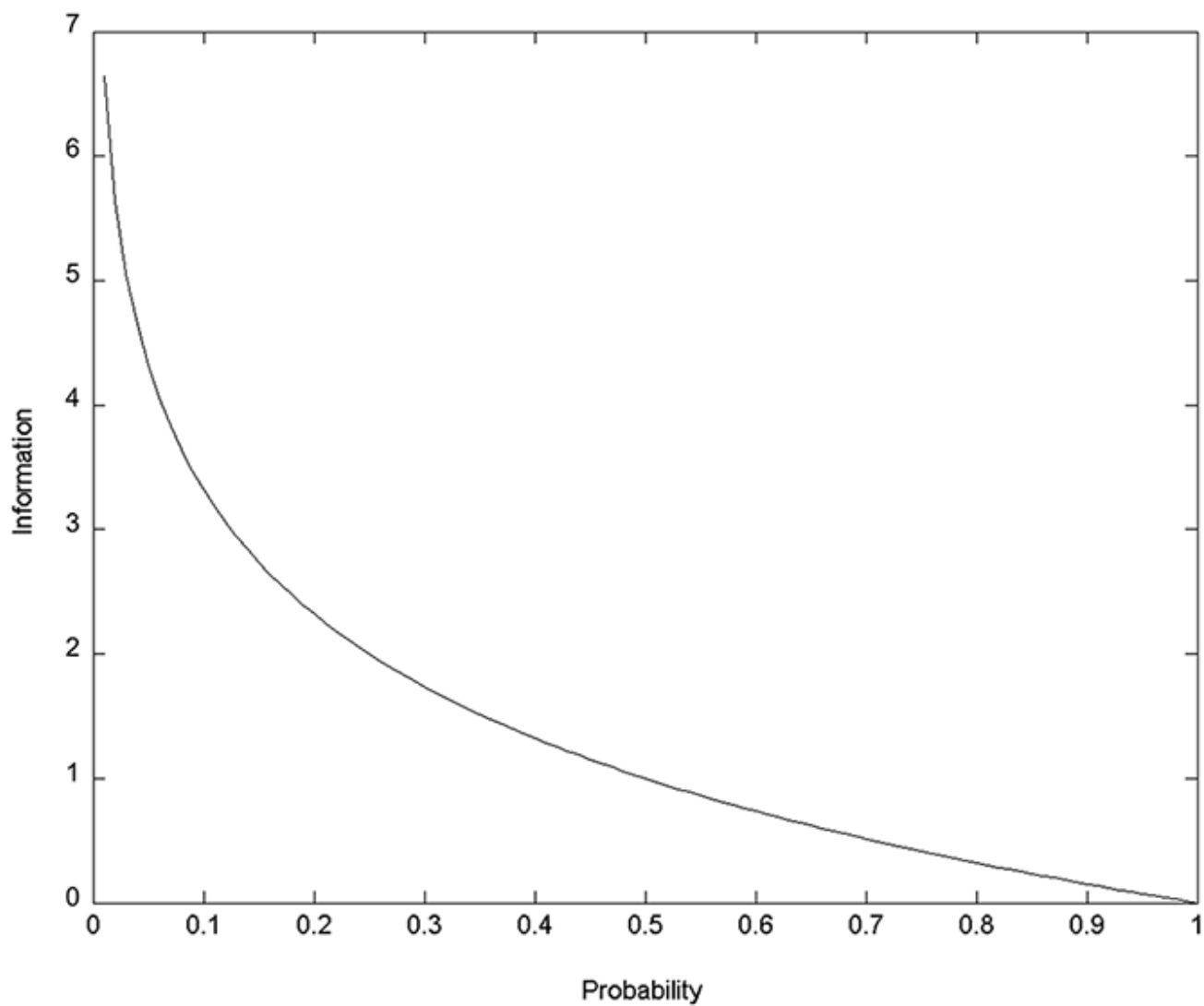


**MTO 25.2 Examples: Temperley, Uniform Information Density in Music**

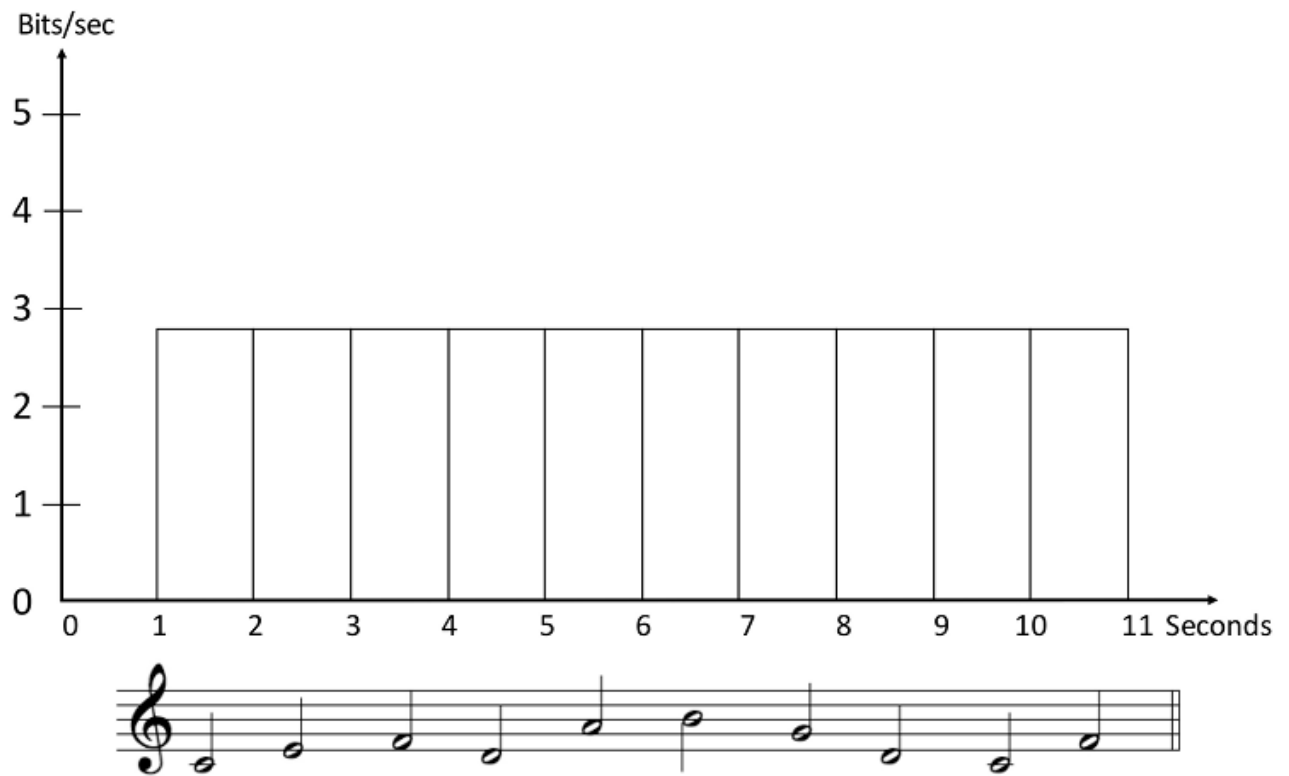
(Note: audio, video, and other interactive examples are only available online)

<http://mtosmt.org/issues/mto.19.25.2/mto.19.25.2.temperley.html>

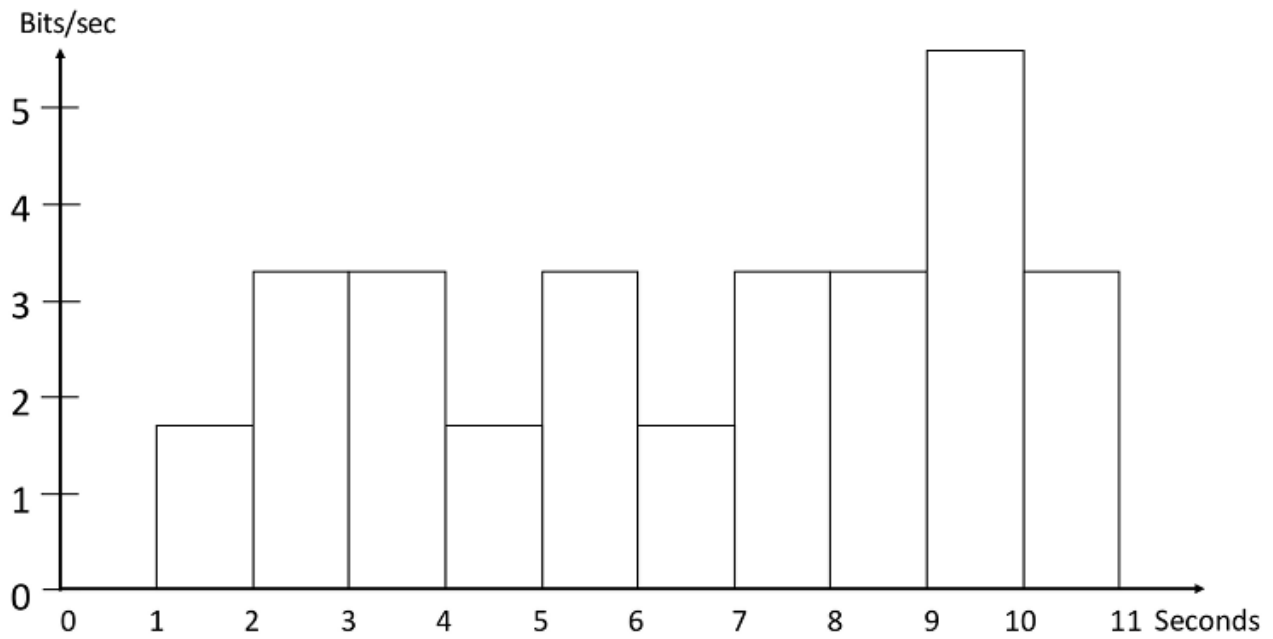
**Example 1.** The relationship between probability and information



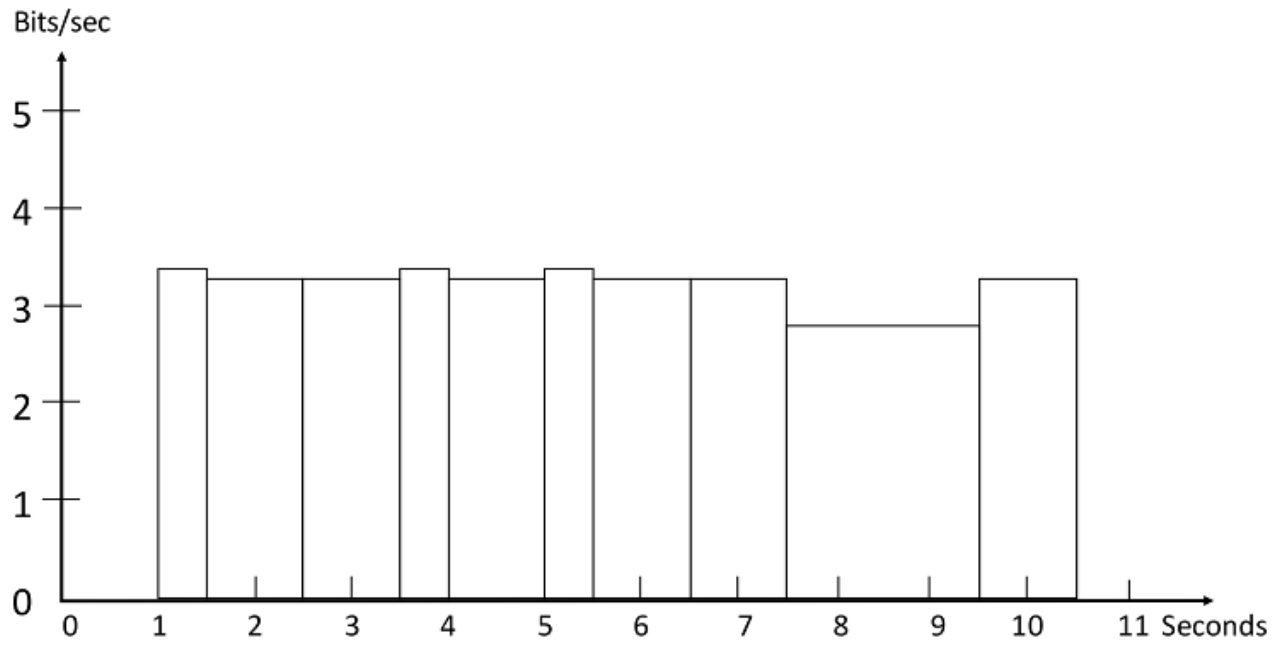
**Example 2.** A 10-note melody, showing the information density (bits per second) of each note, assuming that the seven notes of the C major scale in the octave above middle C each have a probability of  $1/7$



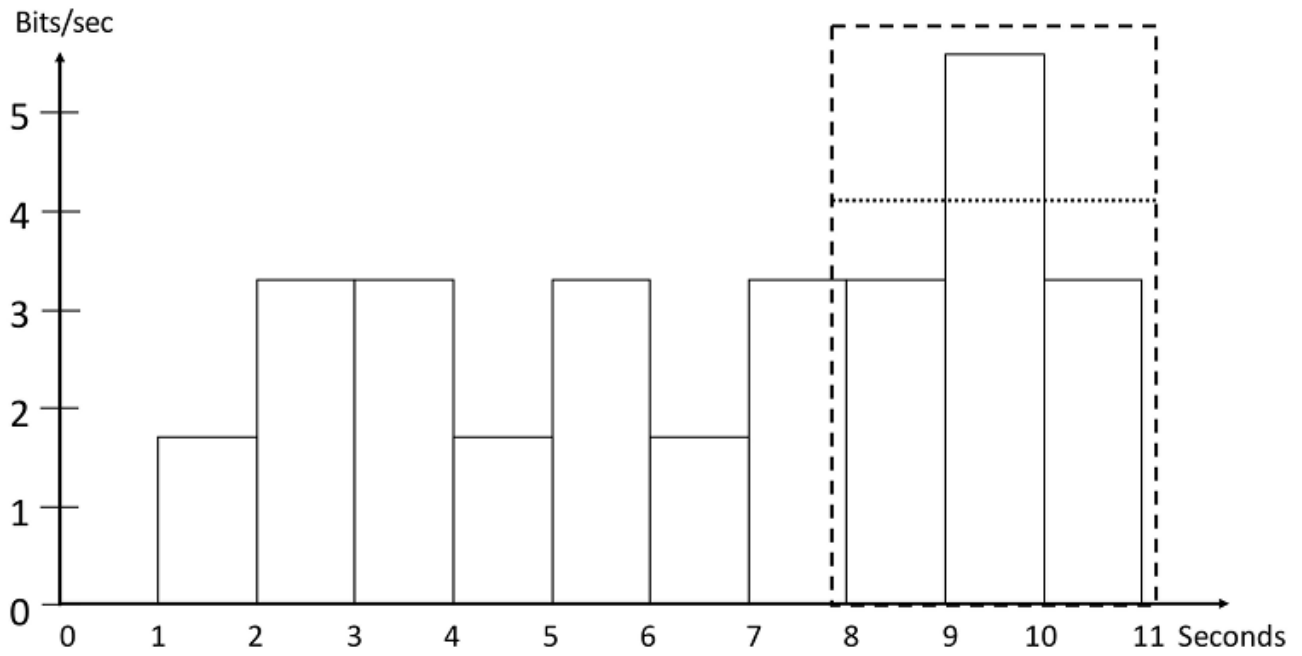
**Example 3.** A 10-note melody, showing the information density of each note, assuming  $P(C) = .3$ ,  $P(D) = P(E) = P(F) = P(G) = P(A) = P(B) = .1$ , and  $P(C\#/D\flat) = P(D\#/E\flat) = P(F\#/G\flat) = P(G\#/A\flat) = P(A\#/B\flat) = .02$



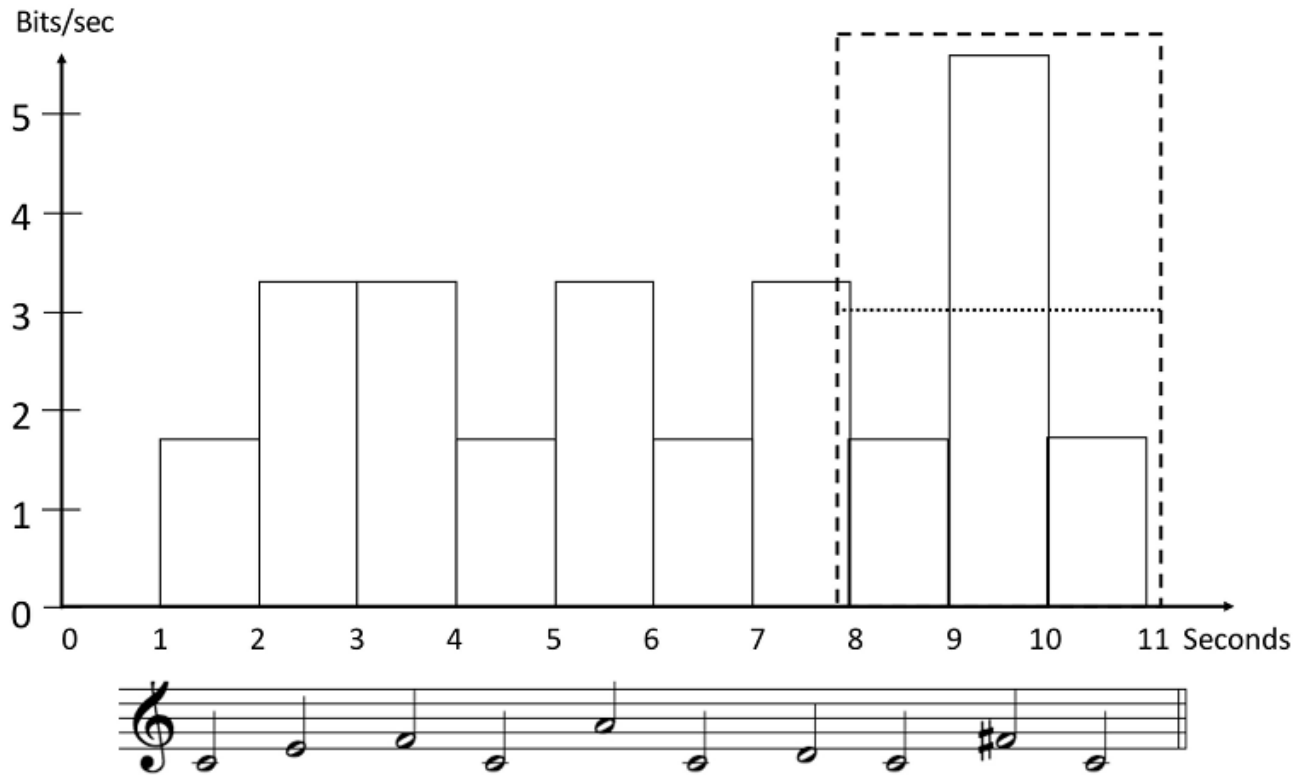
**Example 4.** The melody in Example 3, with the durations of notes adjusted to create a more uniform information density



**Example 5.** The dashed rectangle shows a window of three events within which information density is calculated; the dotted line shows the resulting value (the melody is the same as in Example 3)

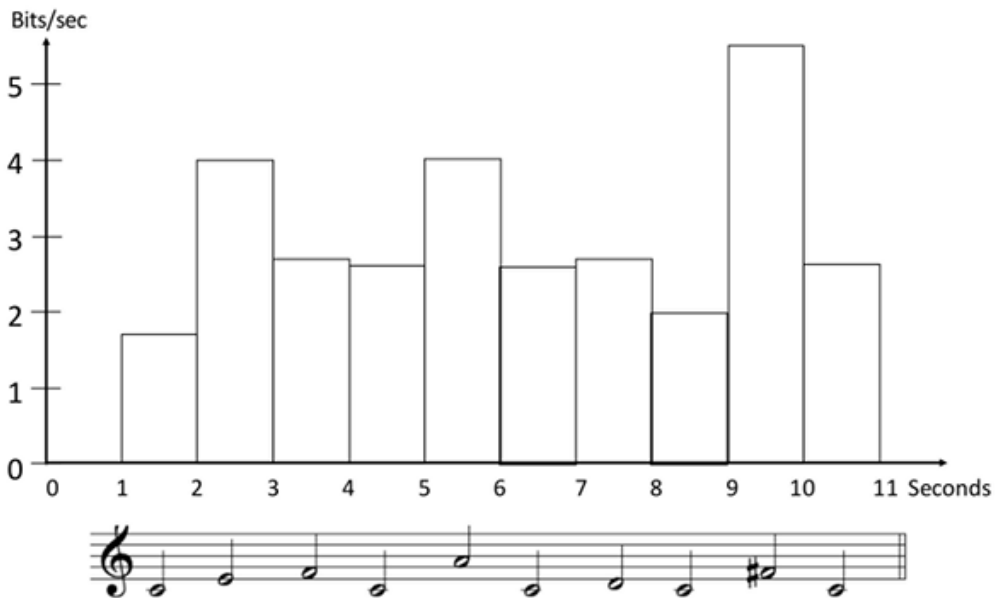


**Example 6.** The melody is the same as in Examples 3 and 5, except the 8th and 10th notes are altered, reducing the information density of the last three notes; the dotted line shows the resulting value



**Example 7.** The melody is the same as in Example 6, but now the probability of each note is calculated as the average of its scale-degree probability, SDP (calculated as before), and its interval probability, IntP, where  $P(\text{step}) = .2$  and  $P(\text{leap or repetition}) = .025$ . Calculations are shown in the table above the graph

SDP	.3	.1	.1	.3	.1	.3	.1	.3	.02	.3
IntP	–	.025	.2	.025	.025	.025	.2	.2	.025	.025
Avg.	.3	.062	.15	.162	.062	.162	.15	.25	.022	.162
$-\log(\text{Avg.})$	1.7	4.0	2.7	2.6	4.0	2.6	2.7	2.0	5.5	2.6



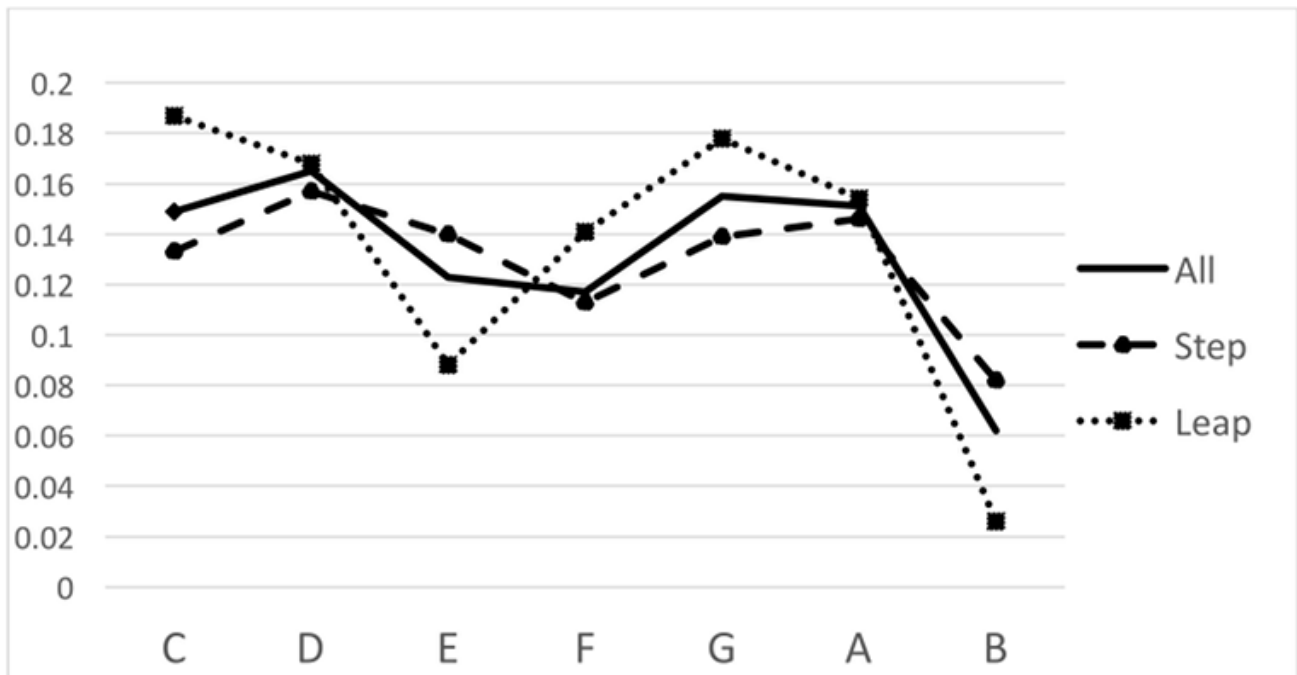
**Example 8.** From Gauldin 1985, 38



**Table 1.** Pre-Leap and Post-Leap Lengthening in Palestrina

	Post-leap (% of notes of each rhythmic value approached by leap)	Pre-leap (% of notes of each rhythmic value left by leap)
♪	0.1	1.1
♪	6.7	5.8
♪	21.8	29.1
◦	27.9	26.6
◻	28.0	39.6

**Example 9.** Pitch classes approached by step and leap in Palestrina masses





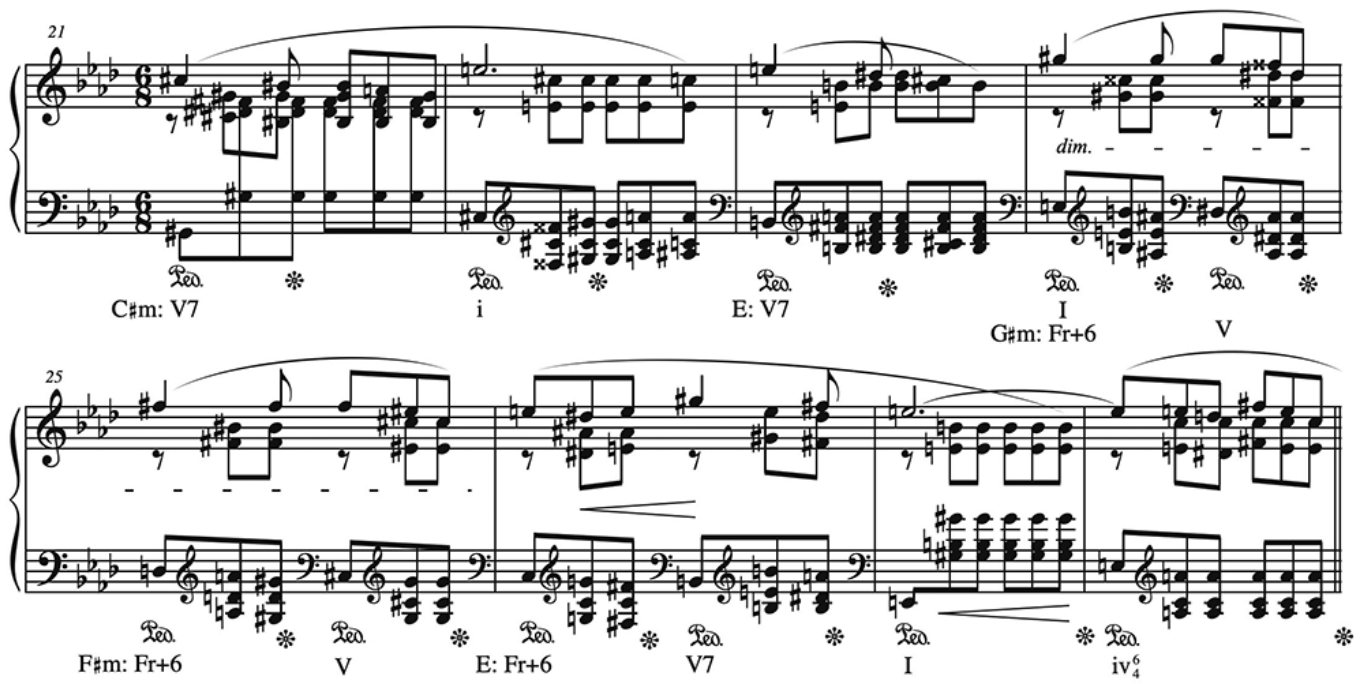
Example 10. From Gauldin 1985, 39



Dó - mi - ne

Example 10 shows a single staff of music in 2/4 time. The melody consists of four notes: a quarter note G4, a quarter note A4, a half note B4, and a whole note C5. The lyrics 'Dó - mi - ne' are written below the notes.

Example 11. Chopin, Prelude op. 28, no. 17, mm. 21–28 (with my harmonic analysis)



Example 11 shows two systems of musical notation for Chopin's Prelude op. 28, no. 17, measures 21–28. The notation includes treble and bass staves with chords and melodic lines. Harmonic analysis is provided below the bass staff, including Roman numerals and figured bass notation.

21

*dim.*

C#m: V7    i    E: V7    I    G#m: Fr+6    V

25

F#m: Fr+6    V    E: Fr+6    V7    I    iv<sub>4</sub><sup>6</sup>

Example 12. A pair of excerpts used in Bartlette's (2007) experiment

A.

First system of musical notation for excerpt A, consisting of a grand staff with treble and bass clefs. The key signature has three sharps (F#, C#, G#) and the time signature is 6/8. The melody in the treble clef consists of eighth notes and quarter notes, while the bass clef provides a steady accompaniment of eighth notes.

Second system of musical notation for excerpt A. A box highlights the third measure of the treble clef, containing the notes G#4, A4, and B4. Below this box, the chord symbol  $ii^6$  is written in a separate box.

B.

First system of musical notation for excerpt B, identical to the first system of excerpt A, showing the same melody and accompaniment in a grand staff.

Second system of musical notation for excerpt B. A box highlights the third measure of the treble clef, containing the notes G#4, A4, and Bb4. Below this box, the chord symbol  $bII^6$  is written in a separate box.

Example 13. Brahms, Intermezzo op. 116, no. 6, mm. 1–8

*Andantino teneramente*

*p dolce e ben legato*

*sost.*

*p*

*espr.*

Example 14. (A) Mozart, “Non so piu” from *Le nozze di Figaro*, mm. 1–5; (B) Mozart, Piano Trio K. 548, II, mm. 1–2

A.

B.

Example 15. Chopin, Nocturne op. 15, no. 2, mm. 1–4

Example 16. Rare types of non-chord tone used motivically. (A) Bach, Aria from *Wachet auf ruft uns die Stimme*, mm. 1–2; (B) Bach, Chorale from *Herz und Mund und That und Leben*, mm. 1–2.

Asterisks indicate escape tones in (A) and anticipations in (B).

Example 17. Mozart, Sonata K. 332, I, mm. 109–23

109

Musical score for measures 109-113. The system consists of two staves: a treble clef staff and a bass clef staff. The key signature is one flat (B-flat) and the time signature is 3/4. The music features a rhythmic pattern of eighth and sixteenth notes with rests. Dynamic markings include *p* (piano) and *f* (forte). Measure 109 starts with a *p* dynamic in both staves. Measure 113 ends with a *f* dynamic in the bass staff and a *p* dynamic in the treble staff.

114

Musical score for measures 114-118. The system consists of two staves: a treble clef staff and a bass clef staff. The key signature changes to two flats (B-flat and E-flat) and the time signature remains 3/4. The music continues with the same rhythmic pattern. Dynamic markings alternate between *f* and *p* in both staves for each measure.

119

Musical score for measures 119-123. The system consists of two staves: a treble clef staff and a bass clef staff. The key signature changes to three flats (B-flat, E-flat, and A-flat) and the time signature remains 3/4. The music continues with the same rhythmic pattern. Dynamic markings alternate between *f* and *p* in both staves for each measure.