

Analyzing expressive differences in historic prelude sets using cluster analysis

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Diverging patterns in mode's associations with other musical cues carry distinctive expressive connotations. The major and minor modes' relationship with loudness and timing are often understood in absolute terms, with major pieces described as being faster and louder than their minor counterparts. However, recent findings suggest mode's relationship to other cues shifted markedly in the Romantic era (Horn & Huron, 2015). Here we expand on previous work using cluster analysis to track expressive changes in music history, applying this technique to Bach's *The Well-Tempered Clavier* (1722) and Chopin's *Preludes* (1839). Analyzing clusters of each composer reveals empirical support for

mode's changing expressive associations. Specifically, Chopin's minor pieces are distinguished by fast attack rates and louder dynamics than Bach's, consistent with research highlighting mode's changing musical meaning. In tandem with our team's work performing perceptual experiments with these pieces, this analysis provides a valuable complement to the small but growing body of research exploring changes in the use of emotive acoustic cues over musical history.

KEYWORDS: *empirical musicology, cluster analysis, cue analysis, historic changes, preludes*

Biases in language production are reflected in musical improvisation: Evidence from large-scale corpus analysis

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Producing language involves the real-time sequencing of words into phrases, leading to considerable demands on working memory that can be relieved by ordering biases in spoken utterances. One such bias is called easy-first: the tendency for more easily-accessible phrases to occur earlier in an utterance, allowing for incremental planning of more complex phrases (MacDonald, 2013). Recent evidence suggests that this bias may extend beyond language to effect other

domains involving real-time action sequencing. In the current study, we sought to test for the presence of the easy-first bias in a creative domain that similarly requires real-time action sequencing: musical improvisation (e.g. Pressing, 1987). Using a corpus of 456 transcribed improvisations from eminent jazz musicians (e.g., Charlie Parker, John Coltrane), we tested for easy-first on multiple definitions of easiness over the phrase and over the corpus: interval frequency,

interval size, interval variety, pitch variety, and direction changes. Similar to language production, our findings suggest that expert improvisers consistently retrieve “easier” melodic sequences before generating more complex and novel sequences, indicating a similarity in the domain-general sequencing biases that facilitate the spontaneous production of music and language.

KEYWORDS: *improvisation, corpus studies, language, action sequencing, hierarchical planning*

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Discovering the line of fifths in a large historical corpus

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An increasing number of corpus studies relies on pitch-class distributions in order to infer characteristics of musical pieces under a historical perspective (Albrecht & Shanahan, 2013; Albrecht & Huron, 2014; Quinn & White, 2017; Weiß, Mauch, & Dixon, 2018; Yust, 2019; Harasim, Moss, Ramirez, & Rohrmeier, 2021).

This contribution shows that the *line of fifths* (LOF; Temperley, 2000) is the fundamental underlying tonal space in a large historical corpus (ca. 1360-1940) of Western classical pieces in MusicXML format. Modeling the pieces’ pitch-class distributions as vectors in a high-dimensional simplicial space and visualizing them via Principal Component Analysis reveals that the distance to the center of the LOF as well as the distinction between the natural (F, C, G, D, A, E, B) and the altered tonal pitch-classes (e.g., Abb, Db, F#, C##) are the most important factors for the dispersion of the data. These findings are robust with respect to different dimensionality reduction methods. Moreover, we

introduce the concept of *pitch-class coevolution* and demonstrate that the LOF also underlies striking changes in the usage of pitch-classes between different historical periods.

Any empirical study is based on certain implicit or explicit modeling assumptions, some of which are given by the encoding of a corpus, e.g. whether enharmonic equivalence is assumed (e.g. MIDI-encoding) or not (e.g. MusicXML encoding). Relying on pitch-class distributions without assuming enharmonic equivalence, our findings emphasize the structural importance of the LOF for the organization of the pitch-class content of tonal music across a large historical timespan.

KEYWORDS: *line of fifths, tonal pitch-classes, dimensionality reduction, pitch-class coevolution, corpus study*

Does order matter? Examining syntactic priming for tonal harmony using corpus-driven methods

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Harmonic priming studies have repeatedly demonstrated that a tonal context primes listeners to expect a tonally related target chord (e.g., Bigand & Pineau, 1997). Tillmann and Bigand (2001) have shown, however, that scrambling the order of chords in the context fails to inhibit processing, suggesting temporal order only weakly contributes to harmonic priming effects. Given the recent claims emerging out of corpus studies of tonal harmony that temporal order is a fundamental organizing principle in many musical styles (e.g., Moss et al., 2019), this study replicates Tillmann and Bigand's experimental design, but trains a probabilistic model on a corpus of chord annotations to select the scrambled conditions.

Sixteen 9-chord sequences were selected from Bach's chorales that either remain unchanged (thereby reflecting *low* temporal incoherence), or were scrambled to produce increasingly incoherent sequences (i.e., *medium* or *high*). To produce the scrambled conditions, a variable-order *n*-gram model (Pearce, 2005) was trained on a corpus of Roman numeral annotations from 100 Bach chorales. It then identified the scrambled versions that produced either medium or high estimates of model uncertainty. Sixty participants (30 musicians) indicated as quickly as possible whether the target chord was in or out of tune. In contrast to previous findings, correct response times from both groups replicated the ascending low-to-high staircase found in the model estimates. Nonmusicians also demonstrated an ascending low-to-high in-tune bias. To our knowledge,

these data provide the first behavioral evidence that harmonic priming effects reflect the order of chords in a sequence.

KEYWORDS: *tonal harmony, harmonic priming, n-gram model*

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Phrase-rhythmic norms in classical expositions: A corpus study of Haydn’s and Mozart’s piano sonatas

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Recent research in phrase rhythm and hypermeter have found that some phrase rhythmic patterns, such as the end-accented “closing-theme schema,” appear regularly in certain parts of the Classical sonata exposition. These phrase rhythmic norms can, therefore, be regarded as the first-level defaults according to the compositional preference hierarchy in Hepokoski & Darcy’s Sonata Theory. However, besides the closing-theme schema, there has been no systematic study to examine the phrase rhythmic norms in the other locations of the sonata exposition. Therefore, this study aims to fill that research gap by conducting a corpus analysis of phrase rhythmic usage in all the first-movement piano sonata expositions composed by Haydn and Mozart (52 by Haydn and 19 by Mozart). This corpus study can then inform our understanding of phrase rhythmic default levels in Classical sonata form as well as any individual differences in the compositional styles of Haydn and Mozart.

In Haydn’s and Mozart’s piano sonatas, phrase rhythm in the primary themes are generally regular, while the secondary themes are mostly irregular. However, in the transitions, Haydn and Mozart have different first-level defaults, with regular phrase rhythm occurring more often in Haydn while irregular phrase rhythm is the norm in Mozart. When irregular phrase rhythms occur, Haydn’s sonatas demonstrate a strong preference to focus on a single loosening device, non-quadruple hypermeasures, while Mozart’s sonatas tend to also include the use of metrical reinterpretations and end-accented phrases. This study also reports on the phrase-rhythmic norms at the boundaries of the sonata formal sections and the hypermetric placements for the MCs, the dominant-locks, and the EECs.

KEYWORDS: *phrase rhythm, hypermeter, Classical form, Sonata Theory, corpus study*

Modeling melodic expectations with expectation networks

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Expectation networks have been proposed as a computationally simple method for learning tonal expectations associated with individual scale degrees (Verosky, 2019). Using principles of activation and decay, expectation networks infer the expectation of encountering a given event type followed in the near (but not necessarily immediate) future by any other event type. The current work outlines how these learned expectations can be used to predict melody continuations and tests the predictions against listener responses to a melodic cloze task previously used to compare two other models of melodic expectation,

IDyOM and Temperley’s Gaussian model (Morgan, Fogel, Nair, & Patel, 2019; Pearce, 2005; Temperley, 2008). Results of multinomial logistic regression indicate that all three models account for unique variance in listener predictions, with coefficient estimates highest for expectation networks. Despite expectation networks’ computational simplicity relative to IDyOM, direct comparisons between IDyOM and expectation networks similarly yielded higher coefficient estimates for the latter. Although all three models are limited in their ability to incorporate global, hierarchical information about pitch structure,

expectation networks seem to benefit from a tendency to predict all three notes of the tonic triad at cadence points while ranking the tonic as the most probable continuation. Our findings suggest that generalized scale degree expectations as captured by expectation networks, stereotypical pitch sequences as captured by IDyOM, and immediate intervallic expectations as

captured by Temperley's model all factor into real-time listener predictions to varying extents, highlighting several possible areas for future work.

KEYWORDS: *statistical learning, melody, expectation, prediction, expectation networks*