Unlocking Key: A Formal Cognitive Model

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A Model of Musical Key

- Key: the hierarchical organization of pitch in Tonal Harmony
- Hypothesis: key is an emergent property of scale schema and tonal attraction
- Tonal Attraction: the dynamic "ebb and flow" of tonal harmonic music
- We propose a predictive mathematical model of key based on psychological processes
- The model uses MIDI numbers and pitch-class integers, and is not dependant on music theoretical definitions of pitch organization (i.e., functional labels, note names)
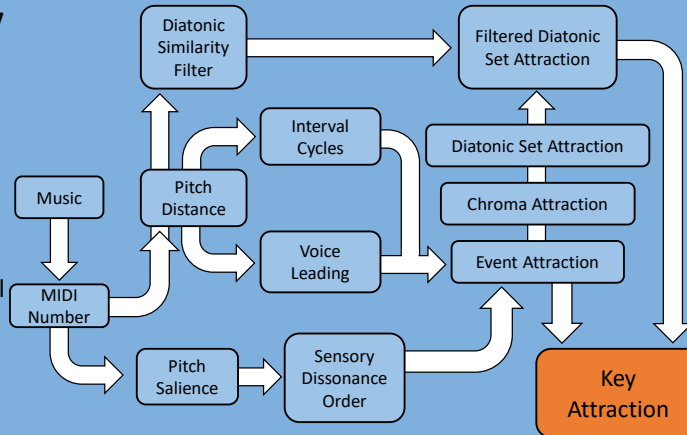

Figure 1: A schematic representation of the model

Model Components

Tonal Attraction
- Woolhouse's (2009) model of tonal attraction hypothesizes Interval Cycle Proximity is responsible for the perception of tonal attraction between adjacent elements,
- Diatonic set and chroma attraction expand this hypothesis to include attraction to keys and tonics

Diatonic Similarity
- Musical events have degrees of diatonic similarity to the diatonic set of a key
- Diatonic models cannot account for the entire experience of musical key, but are a central part of the tonal harmony and form the basis of the hierarchy (Huron, 1994)

Echoic Memory
- Previous harmonic context influences the perception of key; presently modeled with a harmonic decay function (Huron & Parncutt, 1993)

Additional Modifiers
- Pitch Salience (Parncutt, 1988)
Some pitches, particularly the root of a chord, are more salient than others. A psychoacoustic model identifies the most salient pitch, increasing its weight
- Sensory Dissonance (Parncutt, 1988)
The resolution of sensory dissonance increases tonal attraction
- Voice Leading (Wall, 2020)
Smaller Euclidian distance between pitches are considered more similar than larger distance
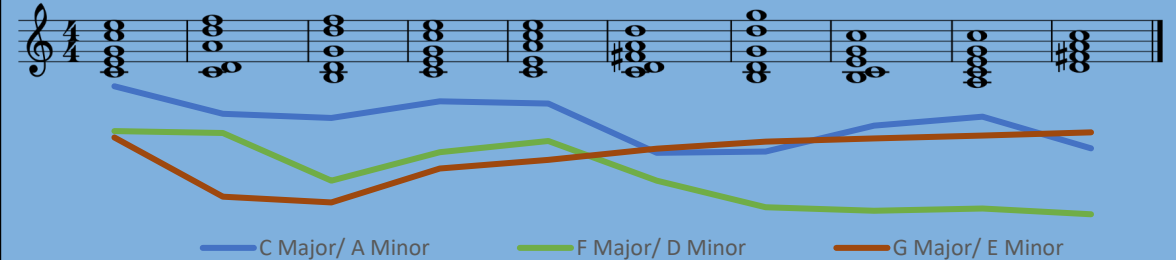
Example Analysis

Figure 2: musical notation and key attraction analysis of J.S. Bach's Prelude in C Major mm. 1-10 (simplified). Keys with the highest key attraction values are above all other keys in the graphic
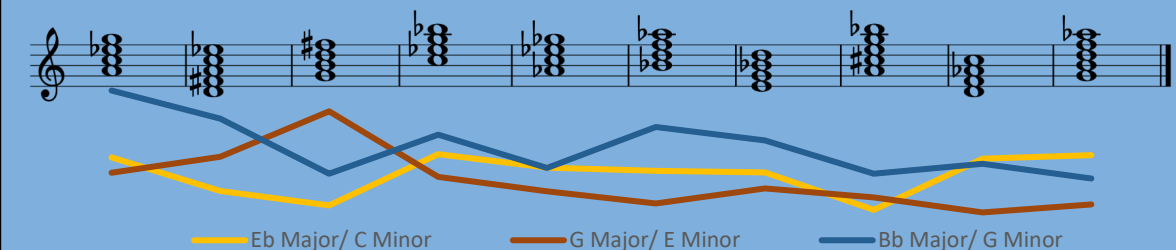

Figure 3: musical notation and key attraction analysis of Victor Young's "Stella by Starlight" mm. 15 - 25 (simplified) as performed by Miles Davis (1964). Keys with the highest key attraction values are above all other keys in the graphic

- Analysis represents the diatonic sets, or keys, a piece of music is most attracted to over time
- The present version of the model does not identify a tonic, only a diatonic set
- The model is particularly effective at analyzing chromatic and functionally ambiguous music (fig.3)

References

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