Emotion in music:
Affective response to motion in tonal space

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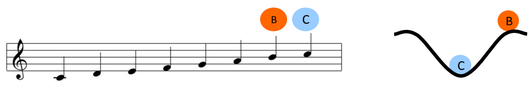
INTRODUCTION

Music perception uses orientation in a tonal system of reference or scale that is defined by perceived tonal stability. Reorientation of a scale within the same composition is called tonal modulation. It is known a priori that modulation can generate characteristic emotional responses. This study explored affective responses to tonal modulation by using controlled stimuli and real music excerpts. The responses were measured with the bipolar adjective scales related to valence, tension, synesthesia, and potency.

Tonal Space

Tonal space or tonal system of reference (scale) is generated by difference in tonal attraction of tones to a stable center – tonic (Lerdahl & Krumhansl, 2007).

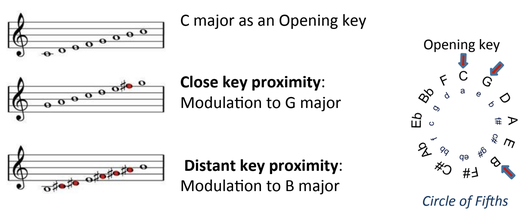


Tonal Force Field

Tonal Force Field is conceptually is analogous to the force field of gravity. A tonic is a "depression" of the phenomenal tonal energy in the tonal space.

Tonal Distance

We can travel in the tonal space on various distances. With each step along the Circle of Fifths, the distance between tonalities grows. The greater is the number of new pitches, the greater is the tonal distance in terms of key proximity.



Reorientation in Tonal Space (tonal modulation)

Today, the dominating system of reference is a 12-tone scale that is made of 7 diatonic and 5 chromatic steps. Thanks to equal temperament, any of the twelve chromatic steps of a diatonic scale can be a target of tonal reorientation.

The major and minor modes generate 4 modal conditions for tonal reorientation:

- from Major to Major
- from Major to minor
- from minor to Major
- from minor to minor

EXPERIMENT 1

Study of affective responses to tonal modulation to all 12 steps and in all 4 modal conditions

METHOD

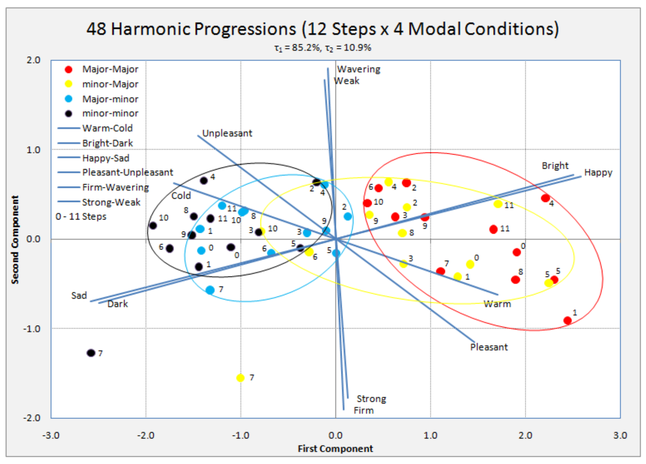
Participants: 54 females and 15 males all of whom were psychology students from the University of Texas at Dallas

Material: 12 harmonic progressions (one for each step), each progression in four modal conditions: from Major to Major, from Major to minor, from minor to Major, and from minor to minor. Each progression was eight-chord long, with smooth modulation to target tonality.

Measurements: six bipolar adjective scales related to valence, synesthesia (warm/cold, bright/dark), and potency (firm/wavering, strong/weak).

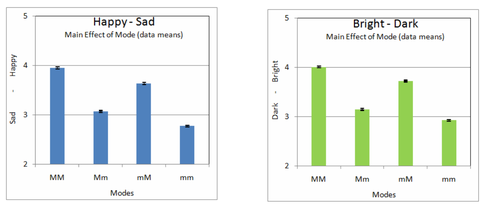
MAIN RESULTS

Affective responses to modulation to all 12 steps and in all 4 modal conditions



- The important dominant (7) and subdominant (5) steps were well differentiated.
- The participants recognized the popular degrees of modulation in a major mode to step 8 and step 1 (the Neapolitan).
- Triads in the major mode are mostly on the side with the positive connotations (happy, pleasant, bright, and warm), whereas triads in the minor mode are mostly on the negative side (sad, unpleasant, dark, and cold).

Influence of the Concluding modal condition

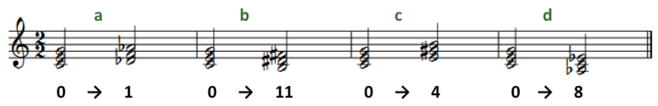


- The Concluding modal condition had stronger influence than the Opening modal condition

Folding in Tonal Space

- The responses to distant steps grouped themselves into "pleasant surprise" versus "unpleasant surprise"

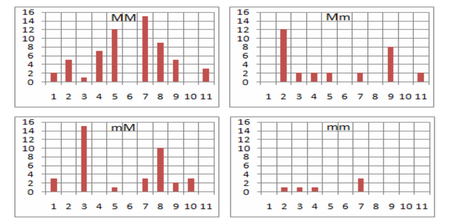
Classification of "pleasant surprise' modulations



"Sliding" type is defined by approaching semitones: a. modulation to step 1 (the Neapolitan) and b. to step 11 (the leading tone).
"Pseudo-stability" type: c. modulation to step 4 converts a mode-defining third of the Opening tonality into a tonic of the Concluding tonality; d. modulation to step 8 converts a tonic of the Opening tonality into a mode-defining third of the Concluding tonality.

EXPERIMENT 2

Study of affective responses to tonal modulation to the subdominant (5), dominant (7) and step 8



Distribution of degrees of modulation in the music of the composers of the First Viennese School and the Romantics

METHOD

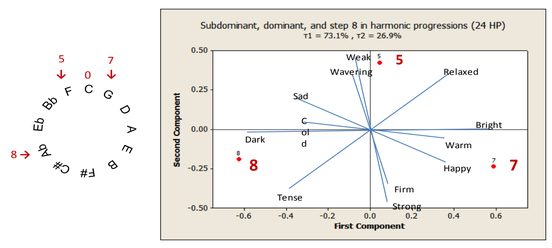
Participants: 49 females and 16 males all of whom were psychology students at the University of Texas at Dallas

Material: 24 harmonic progressions, 8 progression for each step + 24 real music excerpts, 8 excerpts for each step. All stimuli were in Major-Major condition to maintain the ecological validity of modulation to the dominant step. The harmonic progressions were controlled on melodic direction.

Measurements: six bipolar adjective scales related to valence (happy/sad), perceived tension (relaxed/tense), synesthesia (bright/dark, warm/cold0 and potency (strong/weak, firm/wavering)

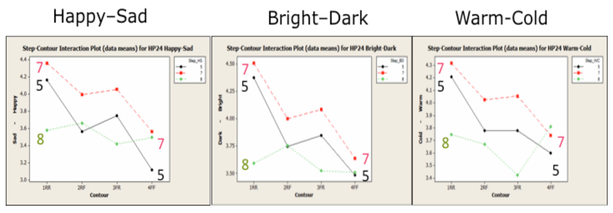
MAIN RESULTS

Emotional responses to modulation to the close subdominant, dominant, and the distant step 8



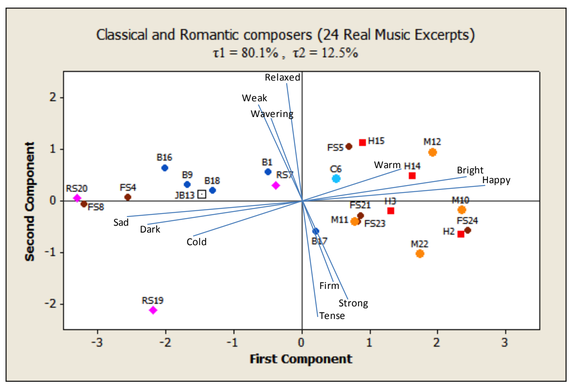
- Modulations to the distant step 8 were perceived as the "tensest" and also as "darker" and "colder" than the modulations to the close subdominant (5) and dominant (7) steps.
- Perceived tonal tension was related to quasi-synesthetic sensations of "brightness" and "warmth."

Affective influence of melodic direction was dampened by tonal distance



Legend: **1RR** = Rising soprano and bass lines; **2RF** = Rising soprano and Falling bass lines; **3FR** = Falling soprano and Rising bass lines; **4FF** = Falling soprano and bass lines. Only Rising-Rising (1RR) and Falling-Falling (4FF) contour patterns were reliably differentiated for the Happy-Sad and Bright-Dark scales, and only 1FF for the Warm-Cold scale (p-value approaching significance for step 8 for the Warm-Cold scale, p = .053).

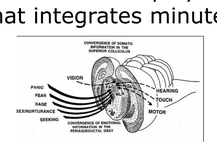
Influence of musical style on perception of tonal reorientation



Mozart (M) and Haydn (H)—the composers of the First Viennese School (XVIII century)—are on the Happy, Bright, and Warm side, whereas the Romantic Schumann (RS, XIX century) is on the Sad, Dark, and Cold side. The "transitional" Schubert (FS) appears on both sides. Labeling: RS= Robert Schumann, FS= Franz Schubert, B= Beethoven, JB= Johannes Brahms, C= Chopin, M= Mozart, H= Haydn.

DISCUSSION

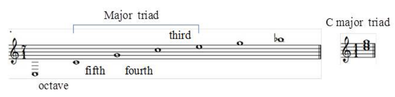
- ***New model of emotional processing in music ("archaic model")***
  - Affective responses in music are generated by the integration of the "gut-felt" sensations produced by the temporally organized interplay of tonal tension and release.
  - The "gut-felt" sensations of tension and release are not emotions; however, their artfully controlled pattern can trigger aesthetic emotional responses that can occur at different levels in the psychophysiological system. Integration of minute sensations according to a tonal-temporal pattern of a particular musical composition results in generation of a particular affective state.
  - The archaic model employs Panksepp's concept of a virtual body image, or the "virtual self" within our paleomammalian brain, that integrates minute somato- and viscero-motor responses to the environment.



Mesencephalic organization of convergent somatic and emotional processes ("virtual self," Panksepp, 2004).

  - The archaic model of emotional processing proposes that the listener's minute sensations of differences in perceived tension acquire affective properties because the sequencing of these sensations in music mimics the way the "virtual self" reflects and integrates the experience of the living organism.

- ***"Hidden" dimension of overtones***
  - A musical sound (melodic "particle") is actually a collection of waveforms. The consonant intervals are composed of tones that share their essential spectral information—the strongest overtones. It is plausible that the pleasing sonic quality of the Pythagorean intervals is related to a neural-cost related advantage for their processing as compared to other, more "tense" melodic compounds



The first four overtones in the harmonic series make a major triad in open position. This might explain the "primeval" role of a major triad as compared to a minor triad.

  - The gradient of neural-cost of auditory processing is perhaps the source of the tonal system of reference.
  - Approaching music in terms of aesthetic pangeometry, which applies the idea of dynamic field to aesthetic emotion, can help our understanding of music cognition.

CONCLUSION

Different degrees of tonal modulation generate different affective responses. Perception of tonal proximity in modulation is related to perceived tension and brightness and warmth. Tonal distance dampens the effect of melodic direction for modulation.
In music, integration of the "gut-felt" sensations, produced by the artfully arranged interplay of tonal tension and release, recreates the logic of emotion in the listener.

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