Harvard-MIT Division of Health Sciences and Technology
HST.725: Music Perception and Cognition
Prof. Peter Cariani

Melody:

sequences of pitches

unfolding in time

HST 725 Lecture 12

Music Perception &

Cognition

(Image removed due to copyright considerations.)

Upcoming topics

Thursday, March 18 (Cariani)

Term project topic presentation & discussion (Stephan)
Melody

Reading: Handel (Chapter 10); Deutsch (Pitch sequences)
Hand out problem set (due April 8th)

Tuesday, March 30 (Cariani)

Presentation on automated music recognitions (Tristan)

Rhythm I: Rhythm perception and production

Reading: Handel (Chapter 11); Deutsch (Clarke chapter)

Also begin looking at Snyder, Music & Memory

Thursday, April 1 (Cariani)

Grouping and expectation

- Time perception, event structure, and temporal expectations
- Auditory spectral and temporal integration; chunking of segments
- Auditory scene analysis and organization of voices
-       Grouping of sounds – onset, harmonicity, rhythm
-       Sound streams (Bregman, Deutsch), polyphony
-       Grouping processes and musical structure
- *Reading: Snyder, Music & Memory; Handel, Ch. 7 Stream Segreg*

Tuesday, April 6 (Cariani)

Music, speech and language: parallels and contrasts
Presentation on tonal languages and music (Stephan)

- Reading: Bigand chapter in *Thinking in Sound*

Upcoming topics III

Thursday, April 8 (Cariani)

Emotion and meaning in music
Musical semantics, music and pleasure
Music and long-term memory
Musical style recognition (Victor)
Problem set due

Tuesday, April 13 (K. Howland, music therapist)
"Clinical applications of the neuropsychology of music." Guest
speaker Kathleen M. Howland Ph.D., MT-BC, CCC-SLP.

Thursday, April 15 (Oxenham)

Clinical issues. Music exposure and hearing loss.
Music perception: hearing impaired listeners & cochlear implant users

Upcoming topics III

Thursday, April 22 (Tramo)

Effects of cortical lesions on music perception & cognition
Music and cortical function: Janata paper (Victor)
Auditory agnosia: Peretz paper (Stephan)
Music therapy: clinical problems and prospects

Tuesday, April 27 (Cariani)

Developmental psychology of music

Thursday, April 29 (Cariani)

A question of origins: comparative & evolutionary psychology of music

Reading: McDermott & Hauser; other readings TBA

Upcoming topics III

Tuesday, May 4 (Cariani)
 Music performance. Organization and timing of movement.

Thursday, May 6
Special topics: absolute pitch, synesthesia, etc.
Audition, vision & other senses: Correspondences & divergences
Synthesis: What would a unified theory of music perception & cognition look like?

Tuesday, May 11
Student Term Project Presentations

Thursday, May 13 (Cariani)
 Overview and recap of major themes;

Monday, May 17 All term projects due, noon.

Tonality and harmony

- Harmony: concurrent sounds, vertical dim.
- Tonality: relating to a tonic (pitch)
- Keys formed by different tonics & scales
- Piston: tonality: note; modality: scale
- Triads, inversions, and degrees
- Krumhansl's probe-tone studies
  - Structure of note-note & note-key similarities
  - Is it just note frequency? Common harmonics?
  - Pitch memory & establishment of tonal centers
- Chord progressions, harmonic distances
- Key modulations, harmonic movements
- Harmonic tension-relaxation dynamics:
  - pitch stability (multiplicity of alt. organizations)
  - movement to & away from tonic (confirmation of 1 pitch framework)

Melody: note sequences unfolding over time

- **Melody: sequences of sounds, vertical dim.**
- **Tonality: relating to a tonic (pitch)**
- **Existence region: tone durations**
- **Intervals vs. contour vs. absolute pitch vs. scale**
- **Tonal vs. atonal sequences**
- **Invariance over key transpositions**
- **Multiple melodic lines: polyphony**
- **Hierarchical structure: phrases**
- **Repetition & change**
- **Formation of expectation & its violation**
- **Melodic memory**
- **Musical preferences: personality, style**

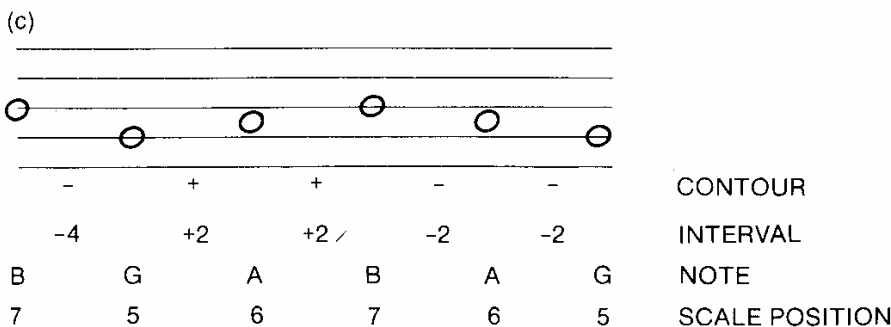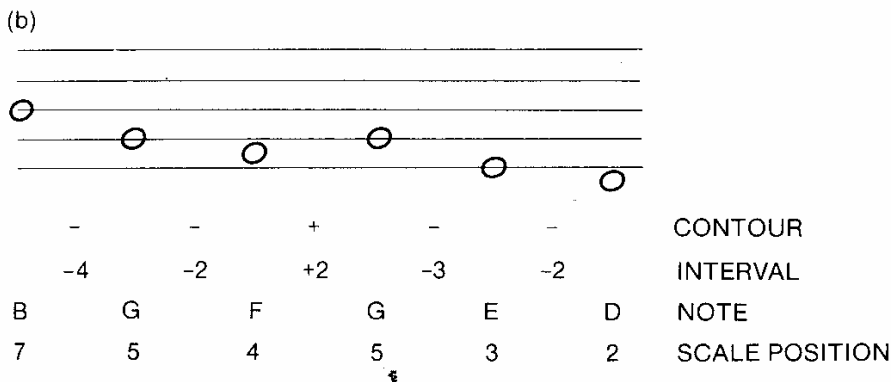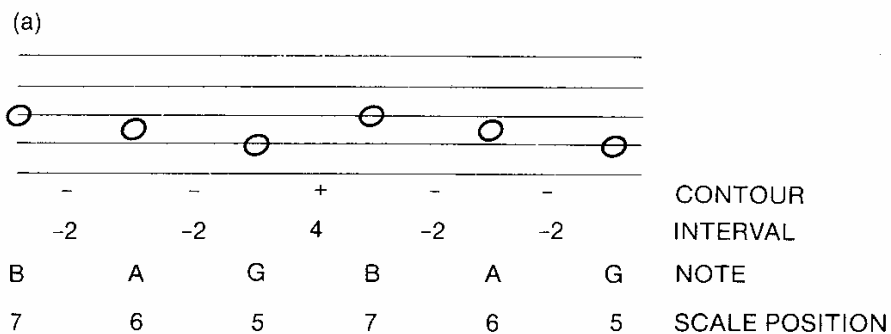# Melody:
contour
interval
note
scale position

(a)

–		–	+	–	–	CONTOUR
	–2	–2	4	–2	–2	INTERVAL
B	A	G	B	A	G	NOTE
7	6	5	7	6	5	SCALE POSITION

(b)

–		–	+	–	–	CONTOUR
	–4	–2	+2	–3	–2	INTERVAL
B	G	F	G	E	D	NOTE
7	5	4	5	3	2	SCALE POSITION

(c)

|						
–		+	+	–	–	CONTOUR
	–4	+2	+2	–2	–2	INTERVAL
B	G	A	B	A	G	NOTE
7	5	6	7	6	5	SCALE POSITION

Figure 10.14
Properties of melodic sequences. Passages can be characterized in terms of the melodic contour, the size of the interval, the actual note, and the position of that note within the key. The first six notes of "Three Blind Mice" are shown in (a). A transformation that maintains the identical contour (––+––) while altering the interval, note, and scale position is shown in (b). A transformation that does not maintain the identical contour is shown in (c).

Establishment of the tonic (tonal system, tonality)

- First note (most salient)
- Last note (most salient in memory)
- Most frequent or longest duration note
- Note pattern may imply a tonic
- Perception of tonic may be influenced by melodic and harmonic context
- Key-finding algorithms have been developed, but these can make errors (i.e. no strict rules apply)
- What does the existence of the tonic imply about pitch memory? about melodic order?

Tonal hierarchy of notes within the key of C

Ranking: similarity to the tonic
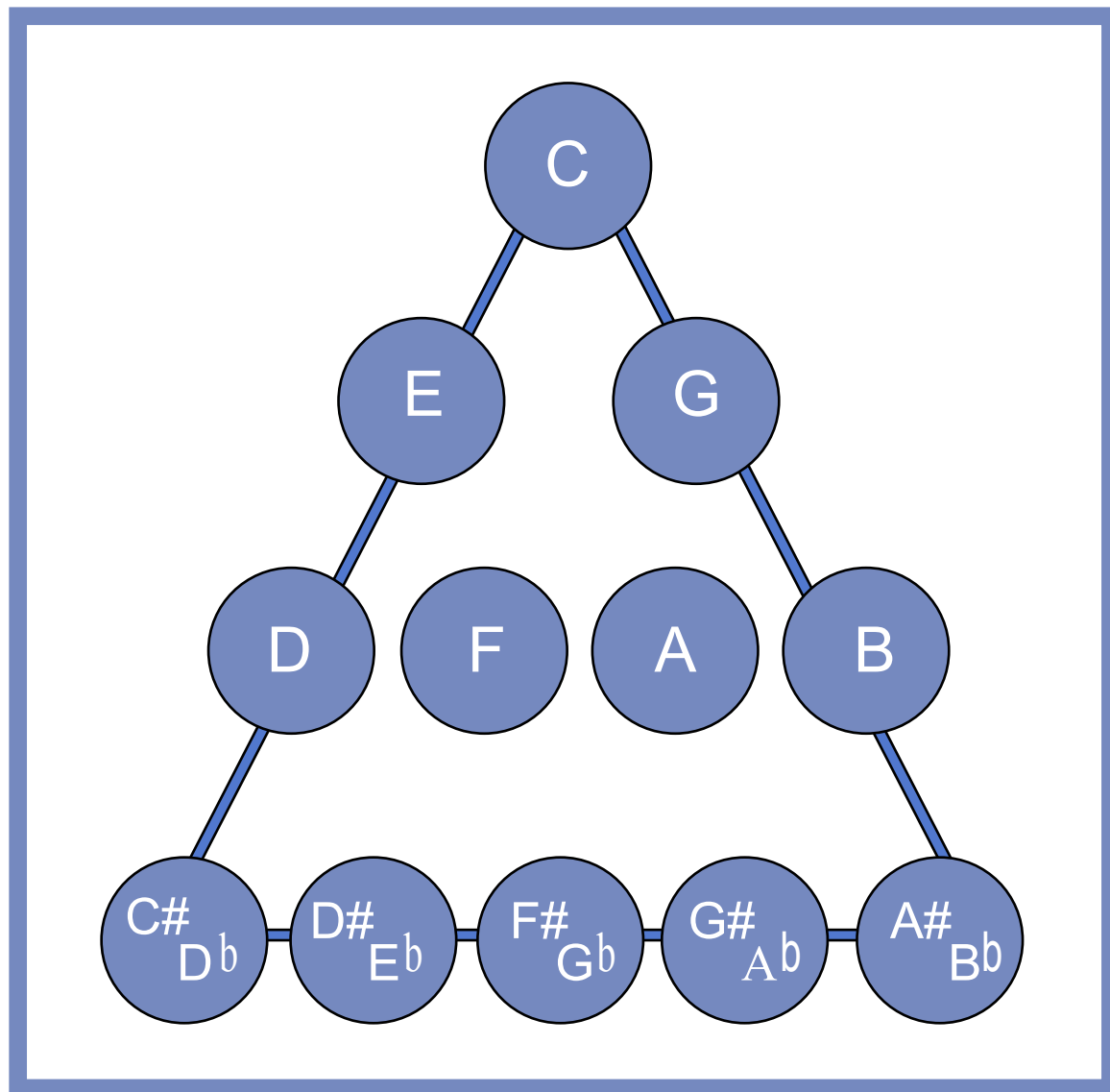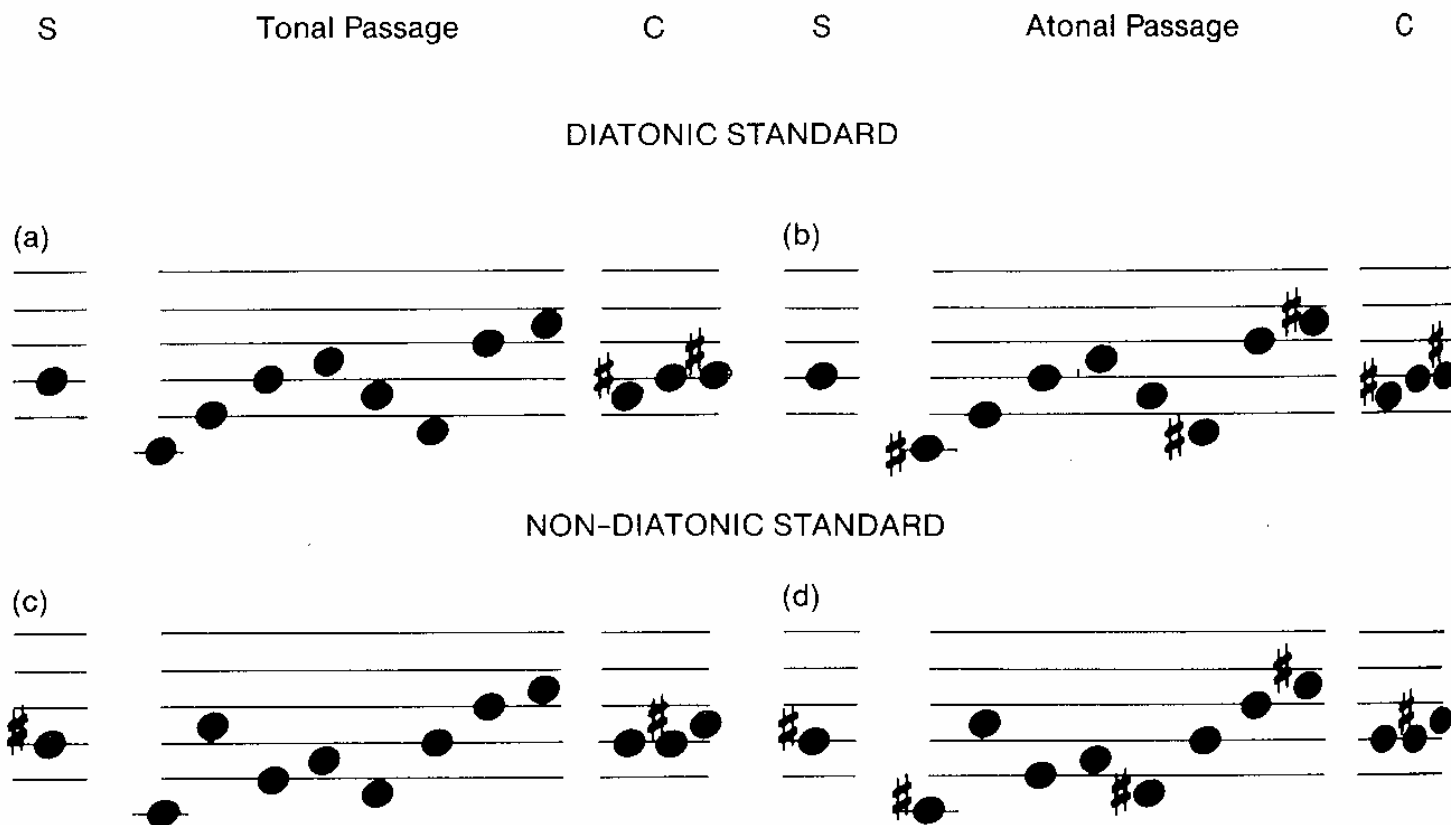
Melody Probe-melody studies

Figure 10.13
Identification of notes within tonal and atonal contexts. On each trial, subjects were presented the standard (S), a short eight-note passage, and then one of the three possible comparison notes (C). The comparison was either the same as the standard (a correct match) or was one semitone higher or lower (an incorrect match). The four variations of the standard note (diatonic vs. nondiatonic) and interpolated passage (tonal vs. atonal) are illustrated in (a)–(d). In addition, the three possible comparison stimuli are displayed (adapted from Krumhansl 1979).

Composition of melodies

Key: From the set of notes in a scale

Chord: From chord progressions

Voice leading:

    transitions

    passing tones

    consonant & dissonant melodic intervals

    create tensions & resolutions

For outline of music theory re: melody in jazz contexts, see

http://www.outsideshore.com/school/music/almanac/html/Music_Theory/Melody/Voice_Leading.htm

Voice leading: predictability/surprise; consonance/dissonance

While the use of scales helps a composer or improvisor select notes to use over a given chord, one rarely would want to simply play the scale itself. The notes of the scale, possibly combined with some non-scale tones, are arranged to form a more interesting melody. This is referred to in classical theory as voice leading. If you think about the typical performance of a jazz composition, the same chord progression is played through many times. If the composition is performed again, the same progression is played many more times. Recall also that one chord progression can be the basis of several different compositions. In the case of a blues progression, it might be literally thousands of compositions on the same chord progression. Furthermore, harmonic analysis of tonal music has become such a science that different chord progressions tend to contain many of the same elements. Creativity in the improvisation of melody is thus extremely important. If melodies were as predictable as chord progressions can become, jazz would not be very interesting. Therefore, while this section discusses some common guidelines for voice leading, do not get locked into treating them as rules that must be followed. Treat them instead as ways of meeting expectations, and remember that creativity comes from the breaking of expectations as well. Many improvisors, even many of those who take a very theoretical approach to harmonic analysis and the selection of scales to use in improvising, rely on their ears alone to guide them in voice leading. Still, the observations made in this section can be useful, and you are encouraged to study them.

For outline of music theory re: melody in jazz contexts, see

http://www.outsideshore.com/school/music/almanac/html/Music_Theory/Melody/Voice_Leading.htm

Melody

What is the essence of melody such that it can be recognized under transformation?

tempo invariant

contour : up/down
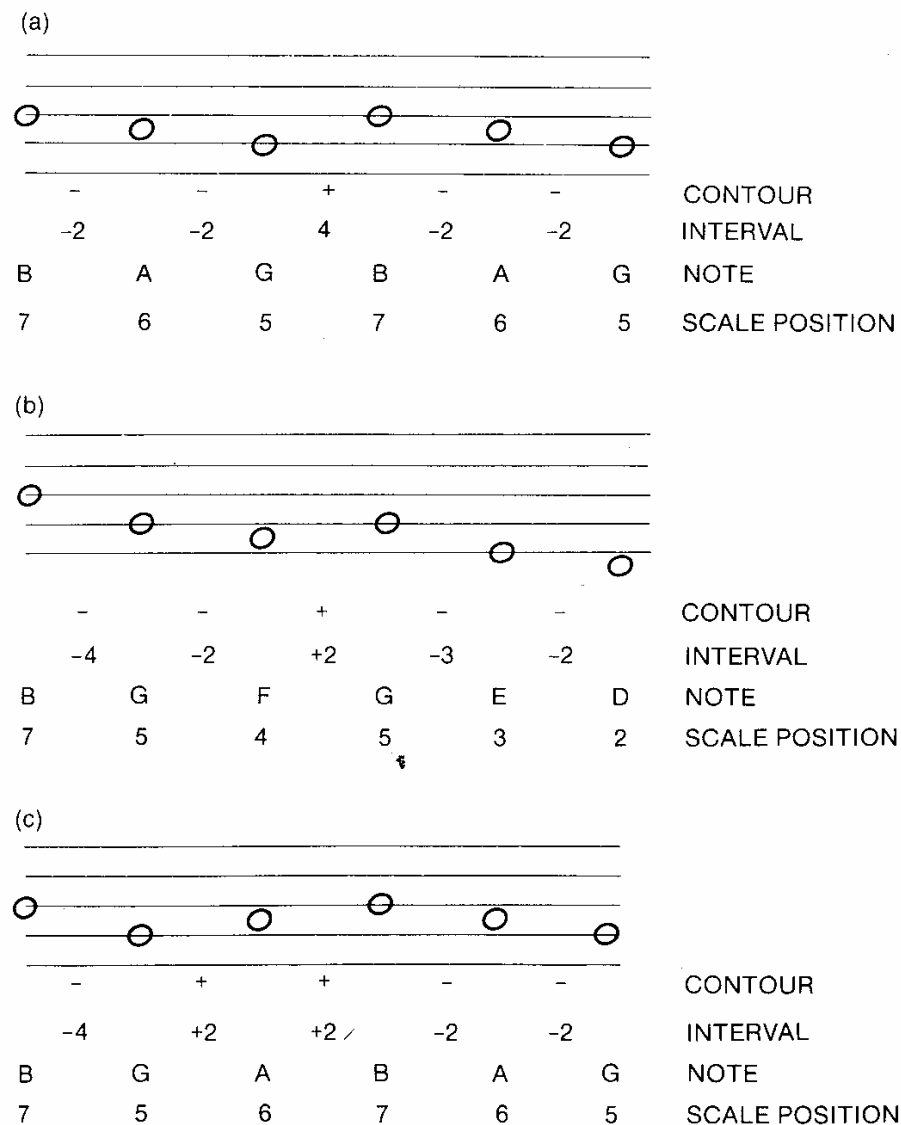**interval: rel. pitch dist.**
absolute pitch: note
scale position: re tonic

(a)

−		−	+	−	−	CONTOUR
−2		−2	4	−2	−2	INTERVAL
B	A	G	B	A	G	NOTE
7	6	5	7	6	5	SCALE POSITION

(b)

−		−	+	−	−	CONTOUR
−4		−2	+2	−3	−2	INTERVAL
B	G	F	G	E	D	NOTE
7	5	4	5	3	2	SCALE POSITION

(c)

−		+	+	−	−	CONTOUR
−4		+2	+2	−2	−2	INTERVAL
B	G	A	B	A	G	NOTE
7	5	6	7	6	5	SCALE POSITION

Figure 10.14

Properties of melodic sequences. Passages can be characterized in terms of the melodic contour, the size of the interval, the actual note, and the position of that note within the key. The first six notes of "Three Blind Mice" are shown in (a). A transformation that maintains the identical contour (− − + − −) while altering the interval, note, and scale position is shown in (b). A transformation that does not maintain the identical contour is shown in (c).
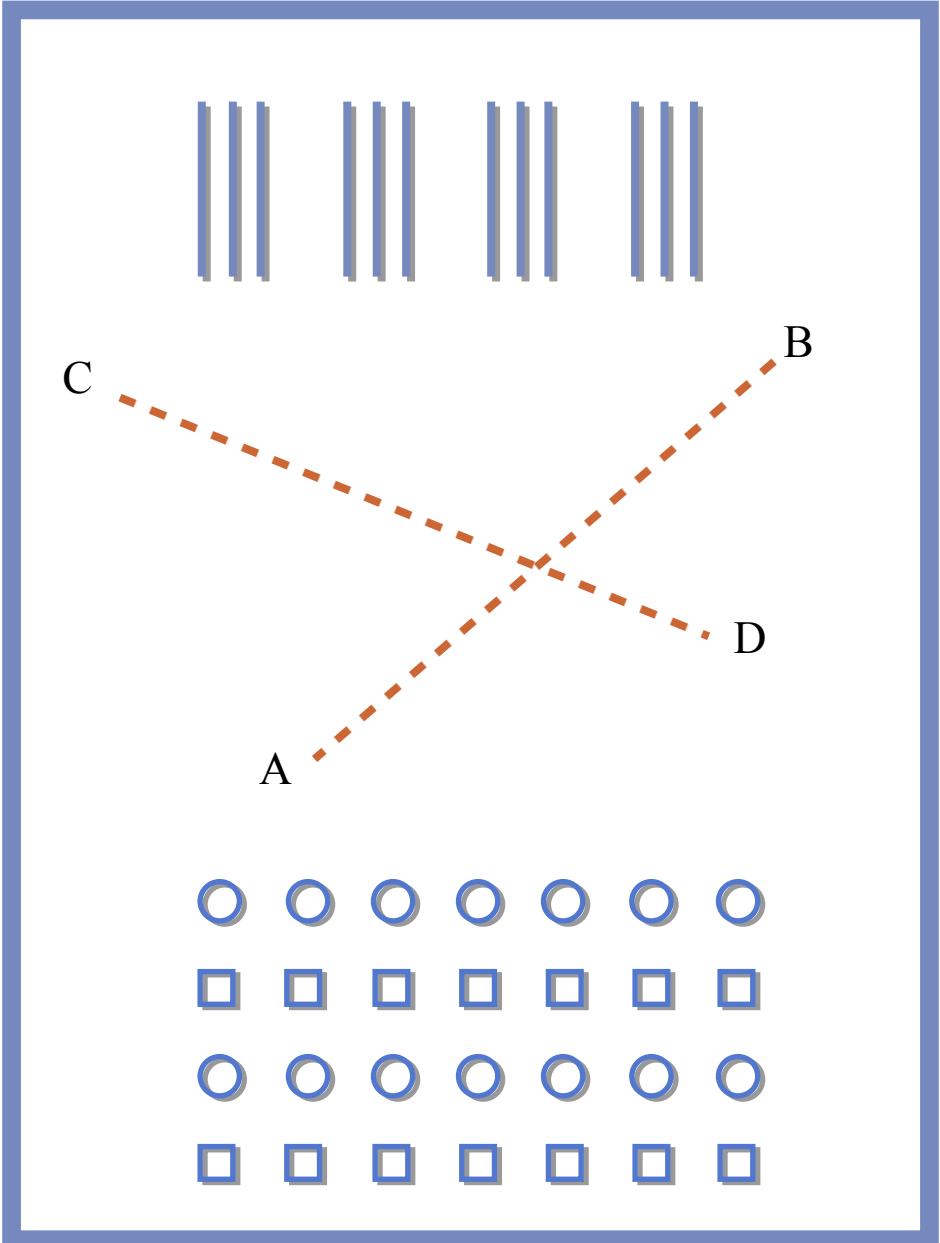
Patterns Illustrating Gestalt Organization
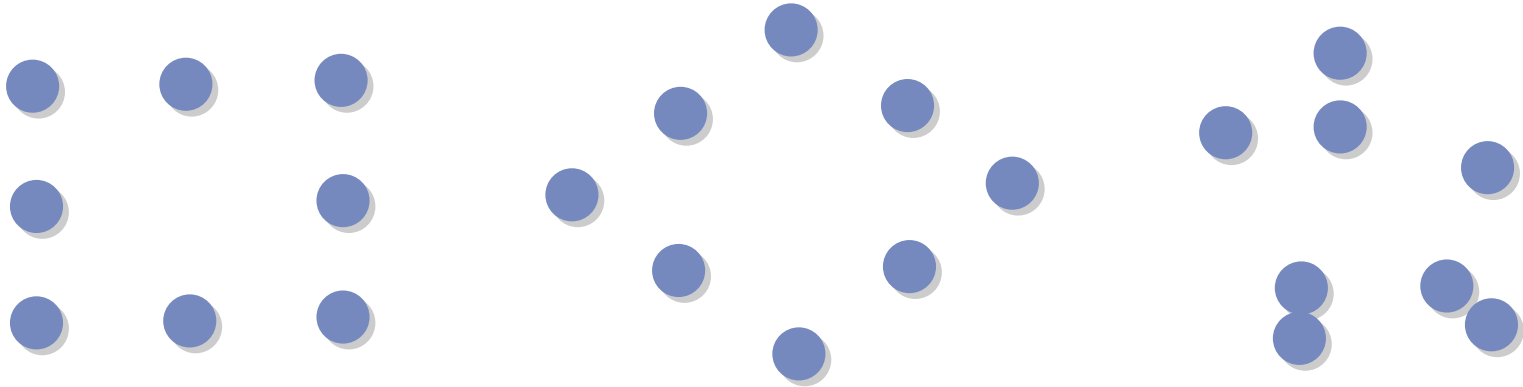
Gestaltist principles
Relations rather than perceptual atoms
Notion of strong vs. weak organization

Principle of simplicity, similarity, proximity, inclusiveness, common fate, closure

Gestalt principles (Jay Dowling, in Aiello)

What makes a "good"or memorable melody?
Coherence of pattern
Balance between order & chaos (surprise)

U-shaped preference curve

Related physiological assumptions:
Relations (Gestaltists) ~ **correlation-based representations**
 vs.
local features (associationists)
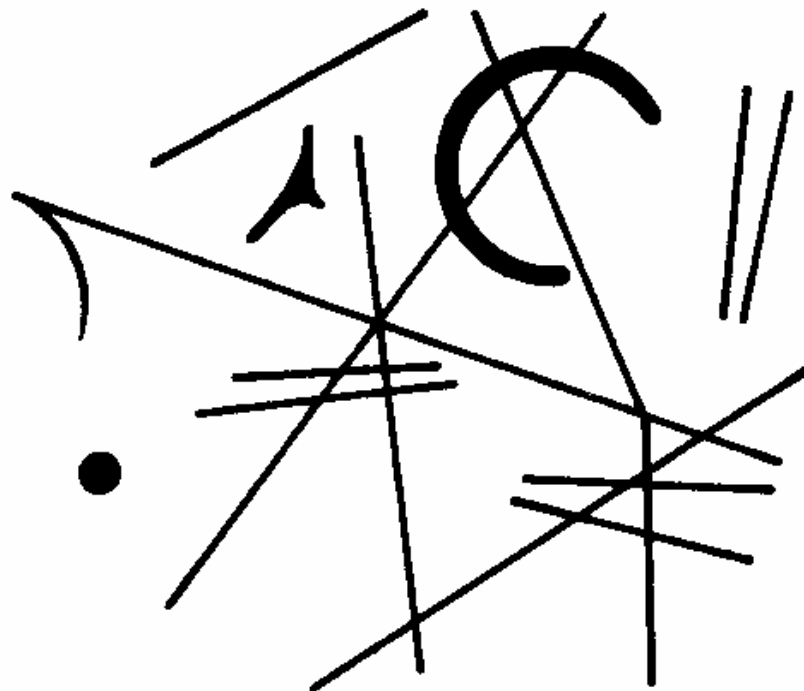   **atomistic feature detectors, machine vision**

Figures from A Primer of Visual Literacy by Donis A. Dondis. Cambridge, Mass., MIT Press [1973]. Used with permission.
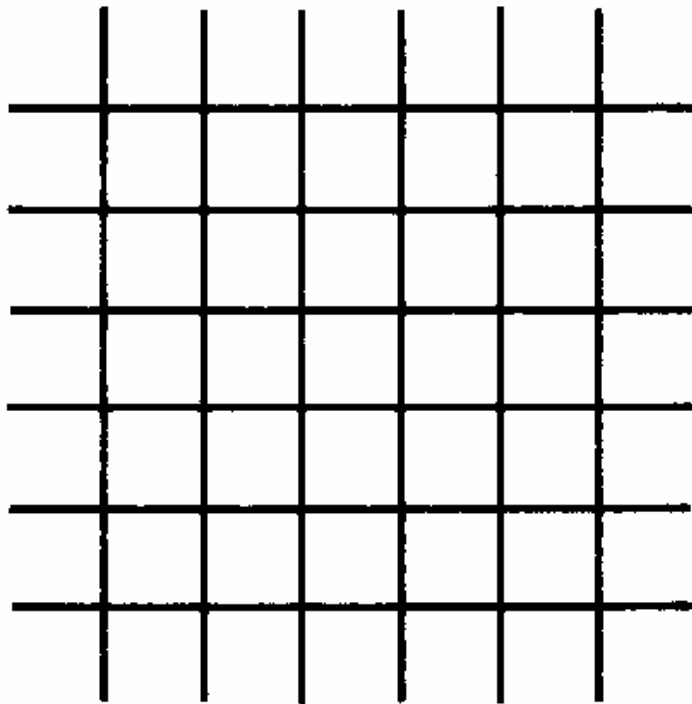
FIGURE 2.12. REPOSE

FIGURE 2.13. STRESS

A Primer of Visual Literacy
Donis Dondis, MIT Press, 1973

Tension-relaxation
Implication-realization (implication-expectation)
**   (from Meyer, 1956, Emotion & Meaning in music)**
cf. Namour's application to melody
Distance from tonic, patterns of stress and relaxation

Mirror invariances (Krumhansl, 1991, p. 163)
under what circumstances is recognition preserved?

- Inversion - invert pitch direction of interval
- Retrograde - temporal order of pitches
- Retrograde inversion - both, i.e. backwards

- Some similarities can be discerned, but "recognition of invariances under the mirror transformations becomes more difficult as rhythmic patterns, octave substitutions, and other variations are introduced (Frances, 1958; Pederson, 1975; Krumhansl et al, 1987)"

Katz (in Musical Networks)

**Attempt to develop
computer models
that behave in a manner
like human listeners in
their evaluation of
melodies**

Please see Figure 15 in *Musical Networks: Parallel Distributed Perception and Performace*. Edited by Niall Griffith and Peter M. Todd.
Cambridge, Mass.: MIT Press,1999.
ISBN: 0262071819.

Melody and Note Durations

Too short:
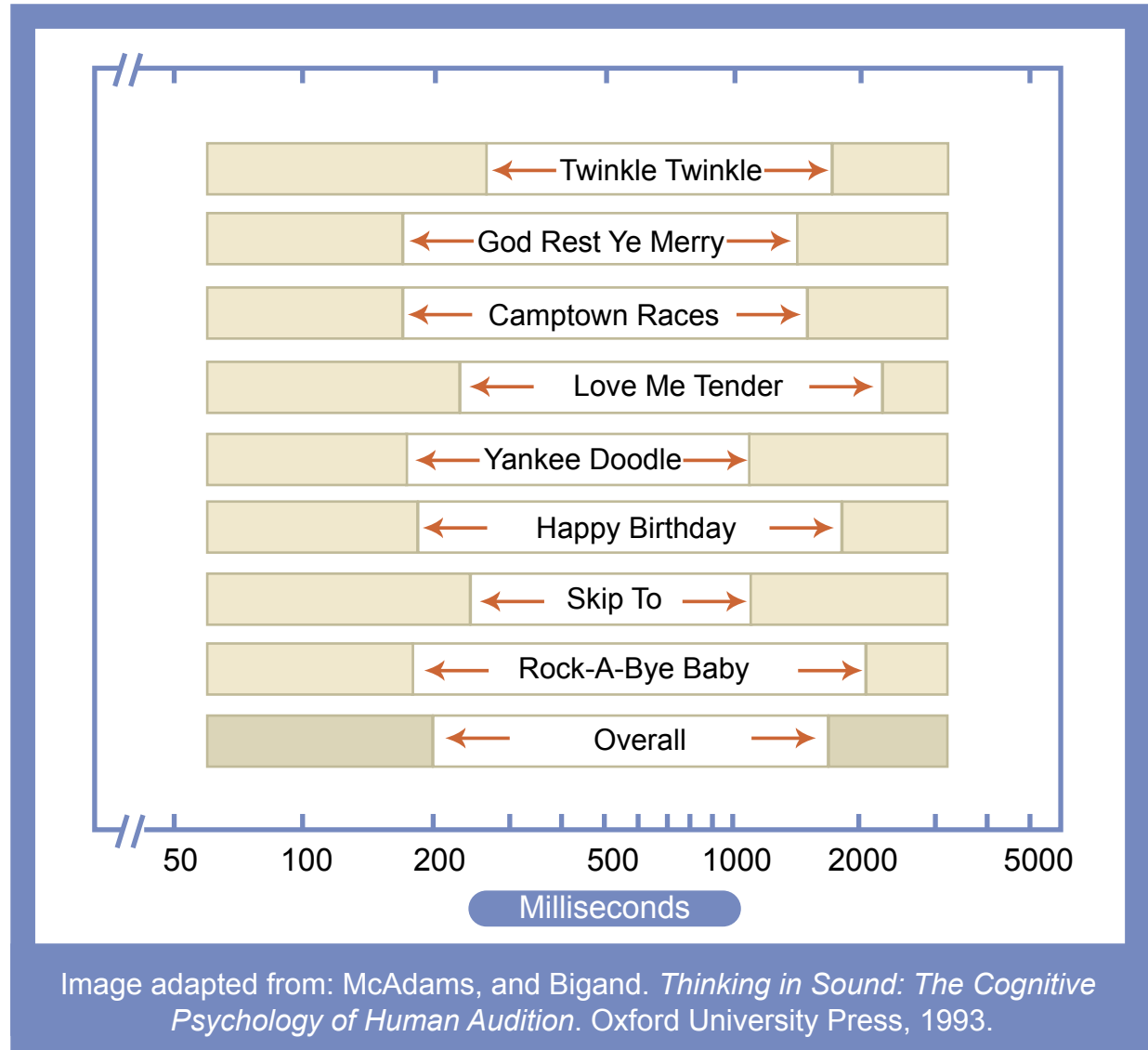## Weak Pitches

Too long:
Lack of interaction between pitches

Image adapted from: McAdams, and Bigand. *Thinking in Sound: The Cognitive Psychology of Human Audition*. Oxford University Press, 1993.

Hierarchies of organization

- Tonal hierarchies
  - Proximity to tonic (key, scale-relations)
- Chord hierarchies
  - Proximity to major or minor triad

- Nested movements in time
- Melodic hierarchies (time)
  - Phrases, themes
- Harmonic movements -
  - chord progressions
  - key modulations

Tonal system schematic (Bigand)

Please see Figure 8.1 in McAdams & Bigand. *Thinking in Sound: The Cognitive Psychology of Human Audition*. Oxford University Press. 1993.

Chord Hierarchies

Distance relations

Greater distance from tonic creates greater tension
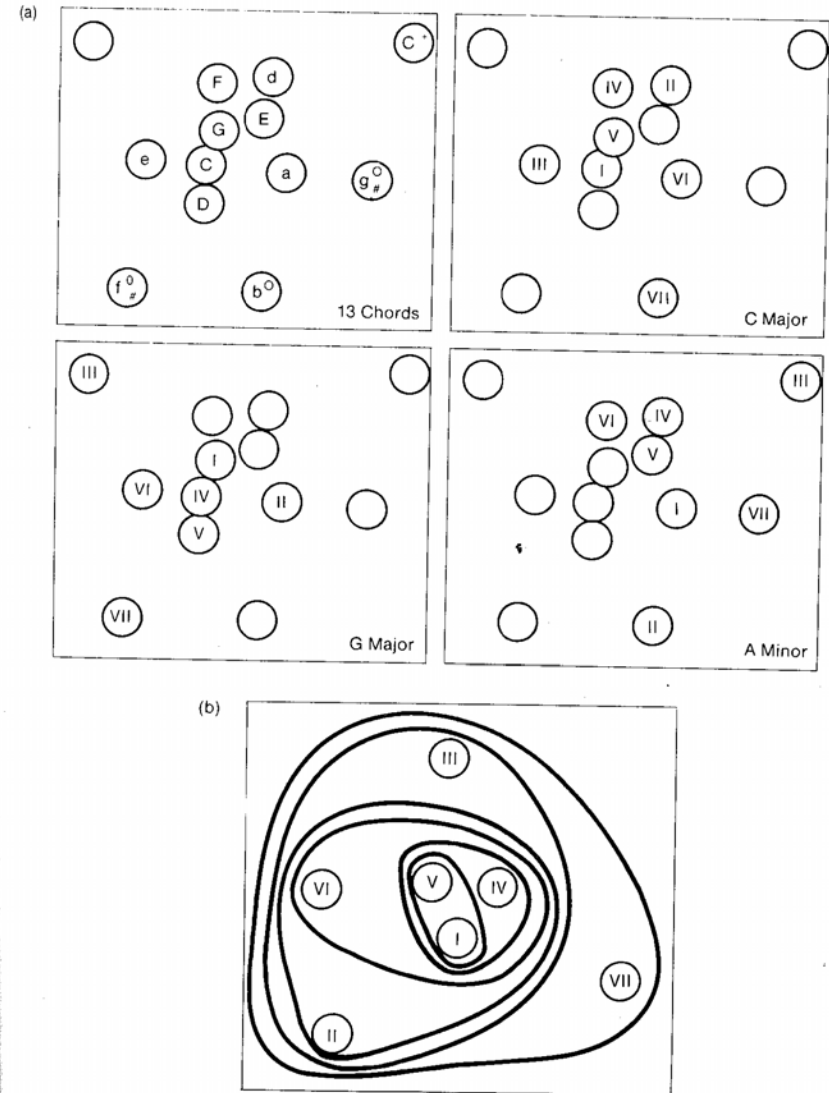
Smaller distance resolves tension

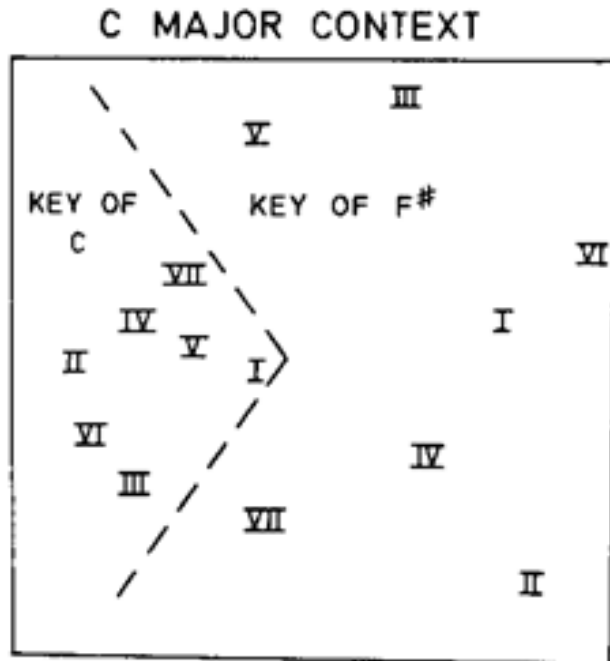C MAJOR CONTEXT

KEY OF C

KEY OF F#

Figure 10.16
Spatial representation of the relatedness or similarity among chords of a scale. The spatial configuration for all thirteen chords is shown in the upper left panel in (a). The remaining three panels show the seven chords of each key separately. The spatial configurations for each key depict the I, V, and IV chords in the middle of the set of chords. This positioning conveys the importance of these chords. The geometrical configuration of the seven scale chords averaged across the three keys is shown in (b). The concentric ovals portray the degree of relatedness among the chords (from Krumhansl, Bharucha, and Kessler 1982 by permission of the American Psychological Association).

Tonal hierarchies: trees, neighborhoods & nestings

Please see Figure 8.3 in McAdams & Bigand. *Thinking in Sound: The Cognitive Psychology of Human Audition*. Oxford University Press. 1993.

Chord progressions, "cadences"

sequences of chords

tension & relaxation instability-stability

Please see Figure 10.7 in Zuckerkandl, Victor. *The sense of music*. Princeton, N.J., Princeton University Press, 1959.

Style analysis (La Rue, Guidelines for Style Analysis)
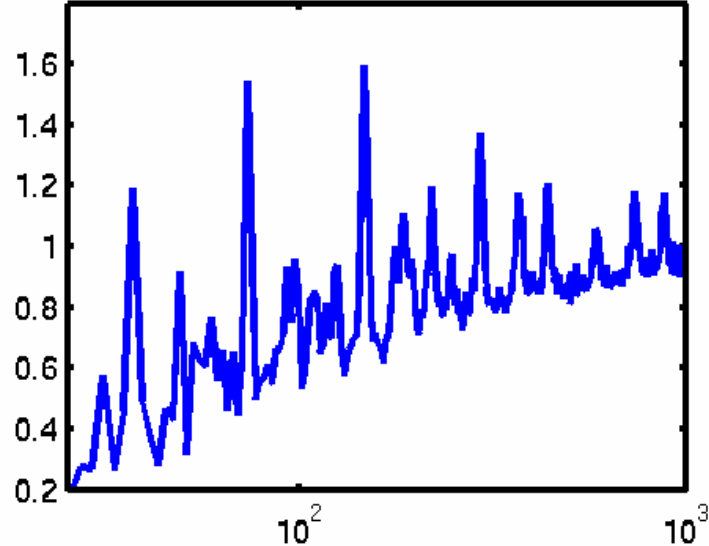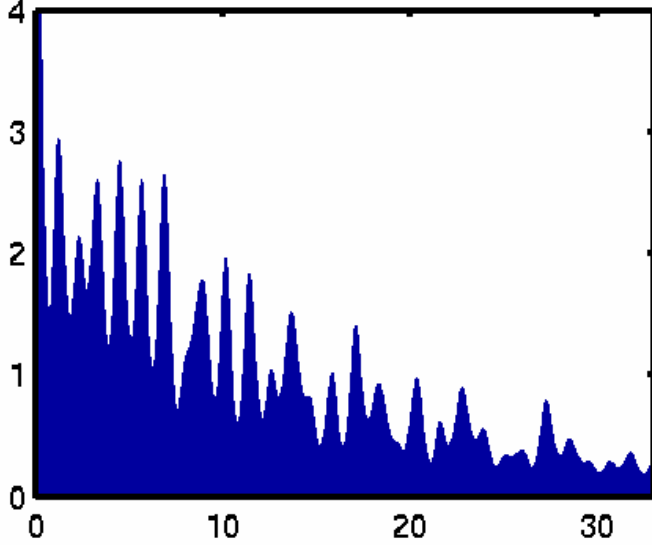
- Sound (texture)
  - timbre, combination, contrast
  - range, gaps, special effects, idiom
- Harmony (functions: color & tension)
  - tonal structure: linear & modal, unifieed, polycentric, atonal, serial, etc
  - Movement relationships: progressions, modulations
  - Part exchange, counterpoint, imitation
- Melody

  Range, mode, vocal/instrumental

  Motion: stepwise, skipping, leaping, chromatic, active/stable, articulated/continuous

  Patterns: rising, falling, sawtooth, undulating, etc.

  Peaks and lows

Style analysis, cont. (La Rue)

- Rhythm
  - Surface rhythm, vocabulary & frequency of patterns
  - Meter, tempo, module (fraction, pulse, motive, phrase, sentence, larger groupings)
  - Patterns of change: stress, lull, transition
  - Fabrics: homorhythmic, polyrhythmic, variant rhythmic density
- Growth
  - systematic movements in musical dimensions, tempos, dynamics, meters, etc
  - Movement: structural/ornamental
- Text influence (lyrics, lyric functions)

Pitch-stability of major and minor triads:
a basis for tension-resolution?

C-Major Triad

CMinor Triad