9.35 Sensation And Perception
Spring 2009

Auditory Scene Analysis

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April 23, 2009

Auditory scene analysis

- Source segregation
  - Spatial separation
  - Spectral and temporal qualities
- Stream segregation
  - proximity: frequency or time
  - continuity: follow trajectory
  - similarity: frequency, timbre, intensity
  - symmetry and closure

Single sound organization

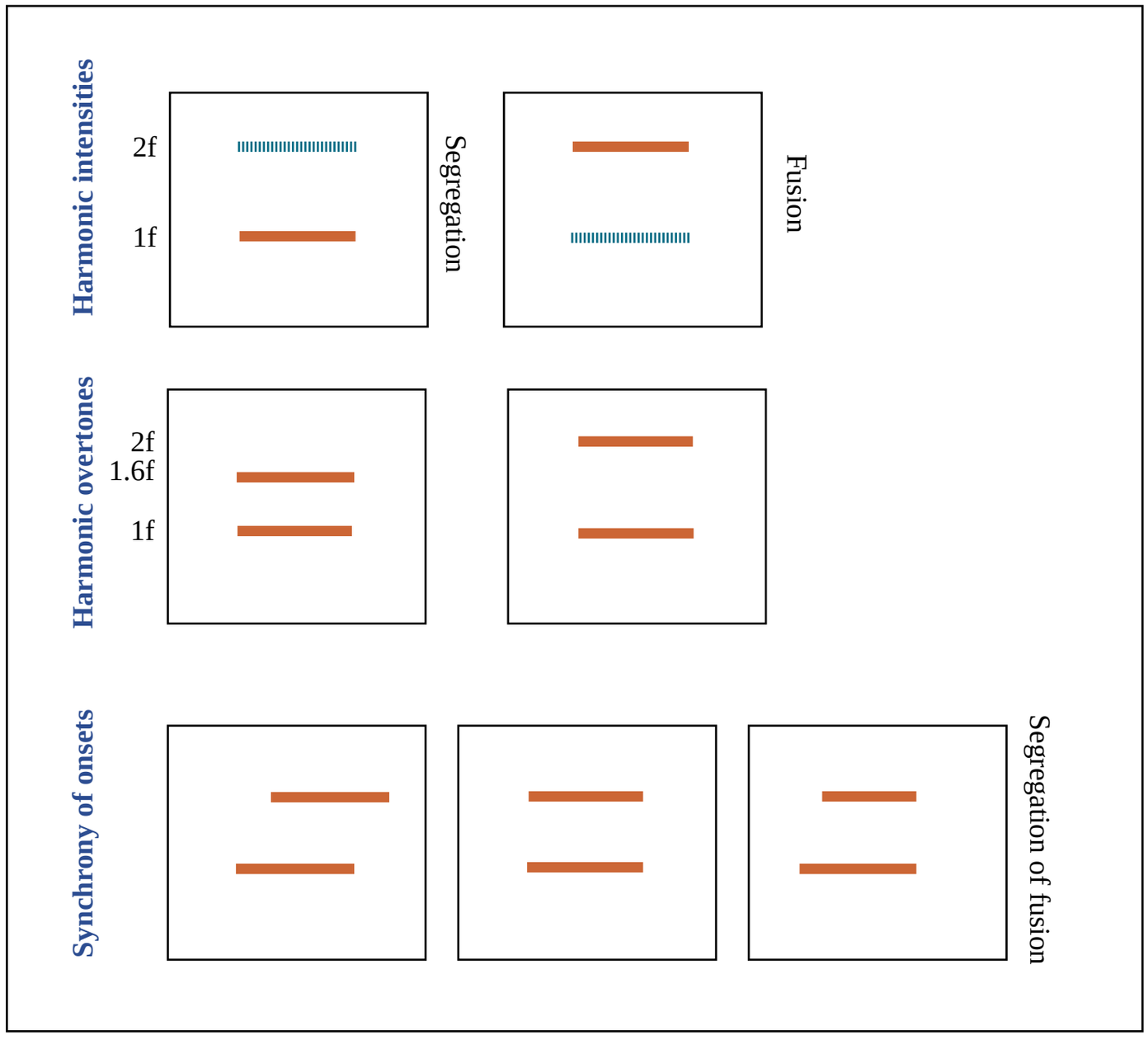

Figure by MIT OpenCourseWare.

adapted from Handel figure 7.2

Old-plus-new heuristic

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Auditory stream

Figures removed due to copyright restrictions.

Stream segregation

- Proximity
- Continuity
- Similarity
- Symmetry and closure

Multiple sounds

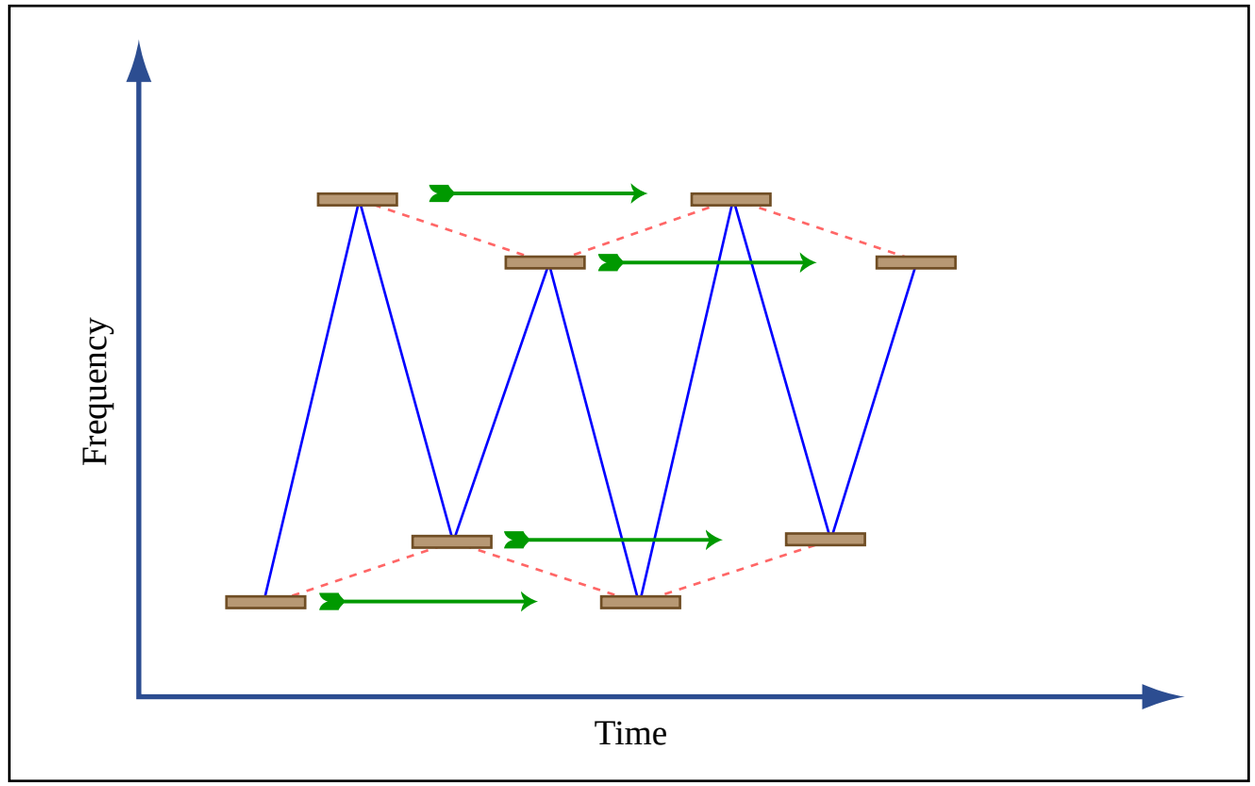


Figure by MIT OpenCourseWare.

adapted from Handel figure 7.4

Multiple sound organization

- Tone sequences
  - Vary parameters to cause perception of subsequences
- Conflicting organizations
  - Ambiguous sequences that put strategies in conflict

Proximity

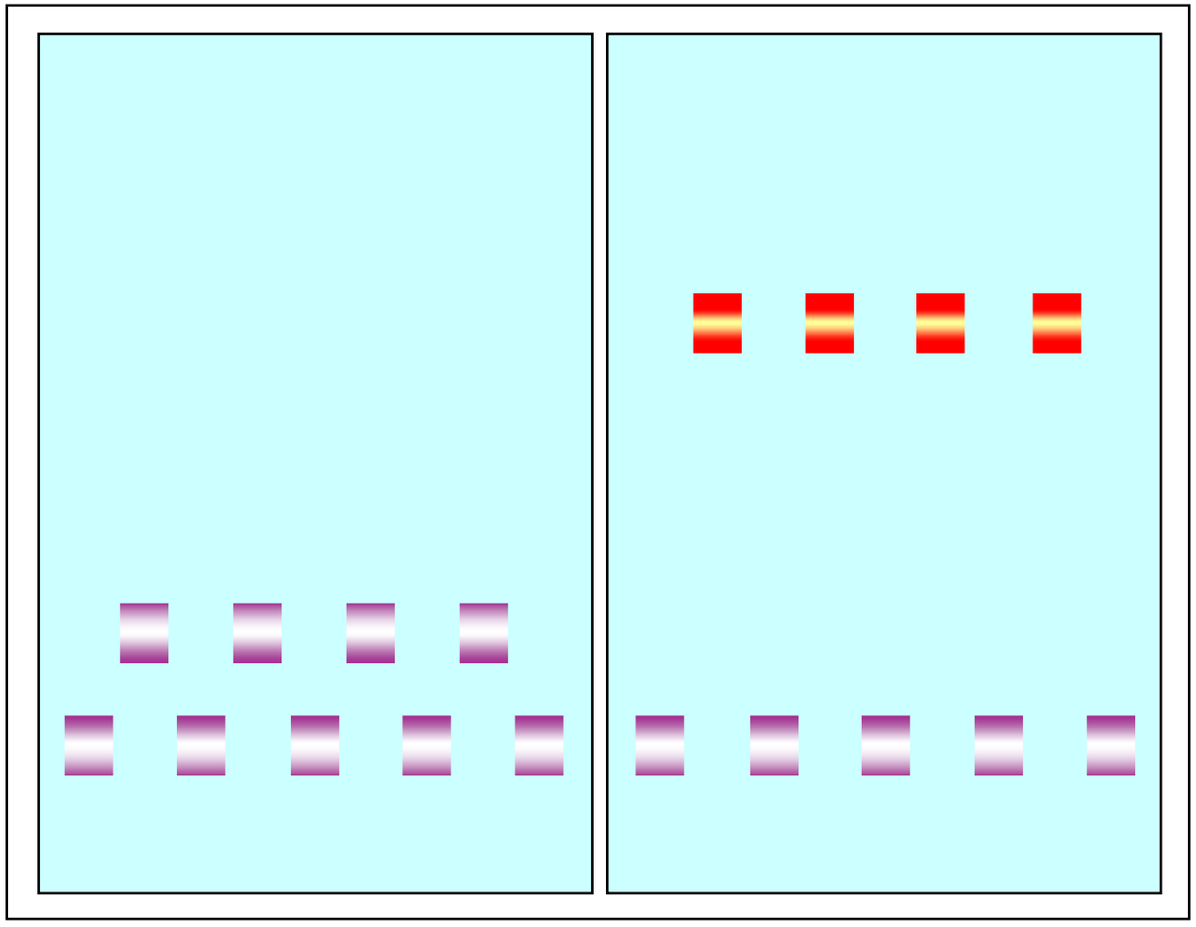


Figure by MIT OpenCourseWare.

Results

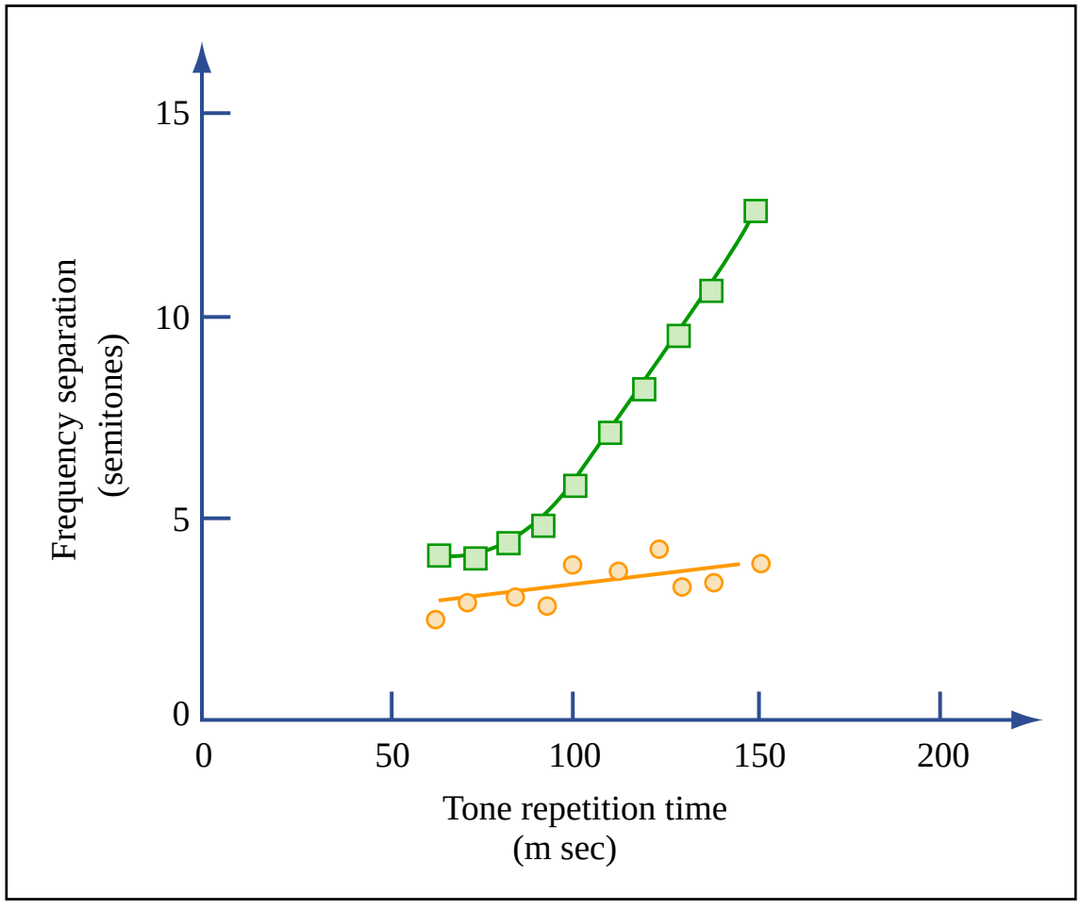


Figure by MIT OpenCourseWare.

from van Noorden, 1975

J.S. Bach

- Toccata and Fugue in D Minor ~1700

J.S. Bach

- Toccata and Fugue in D Minor ~1700

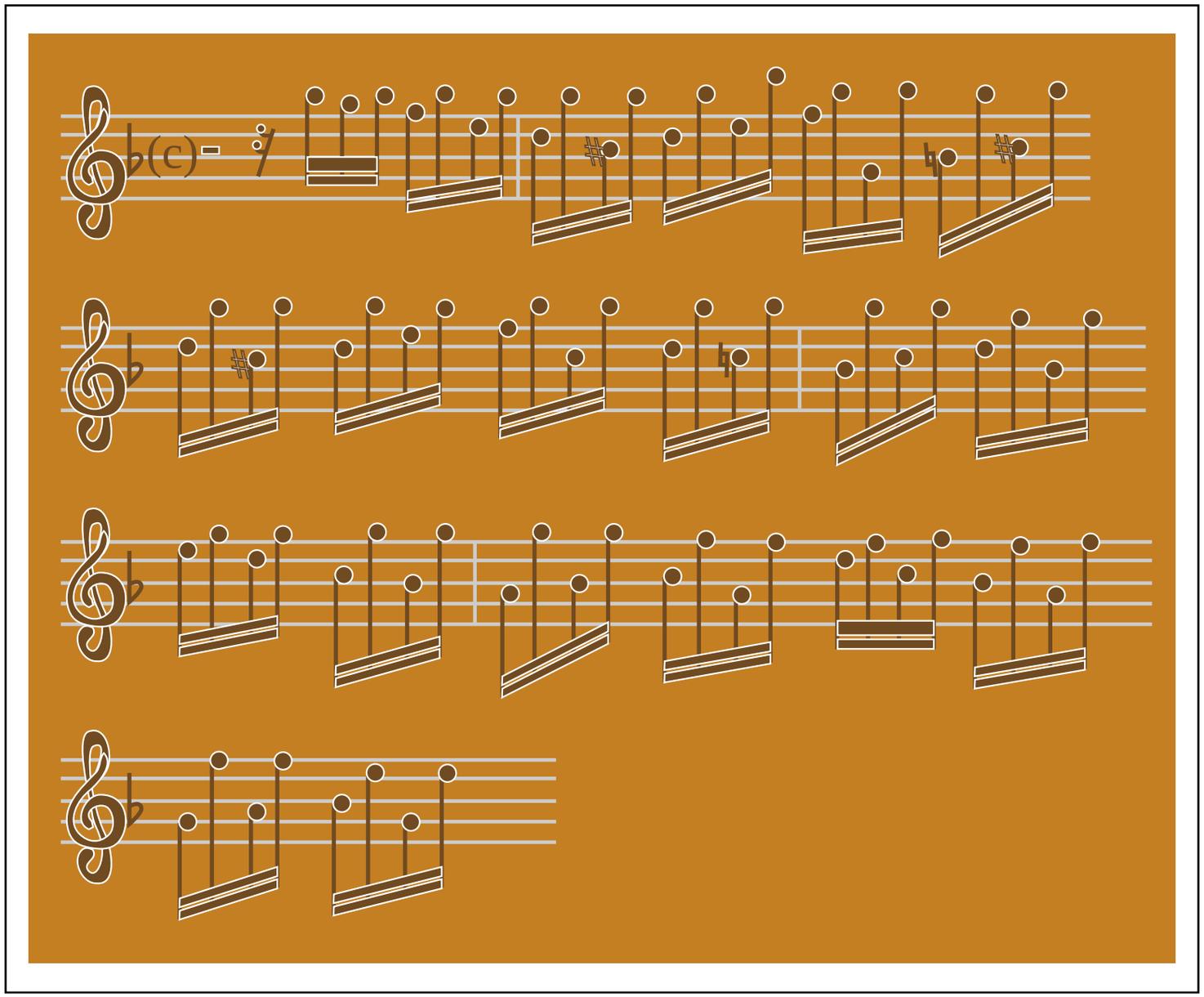


Figure by MIT OpenCourseWare.

Similarity

- Sounds are grouped by timbre

Similarity

- Sounds are grouped by timbre

Example

from *Music, Cognition, and Computerized Sound*, ed. Perry Cook

Competing organizations

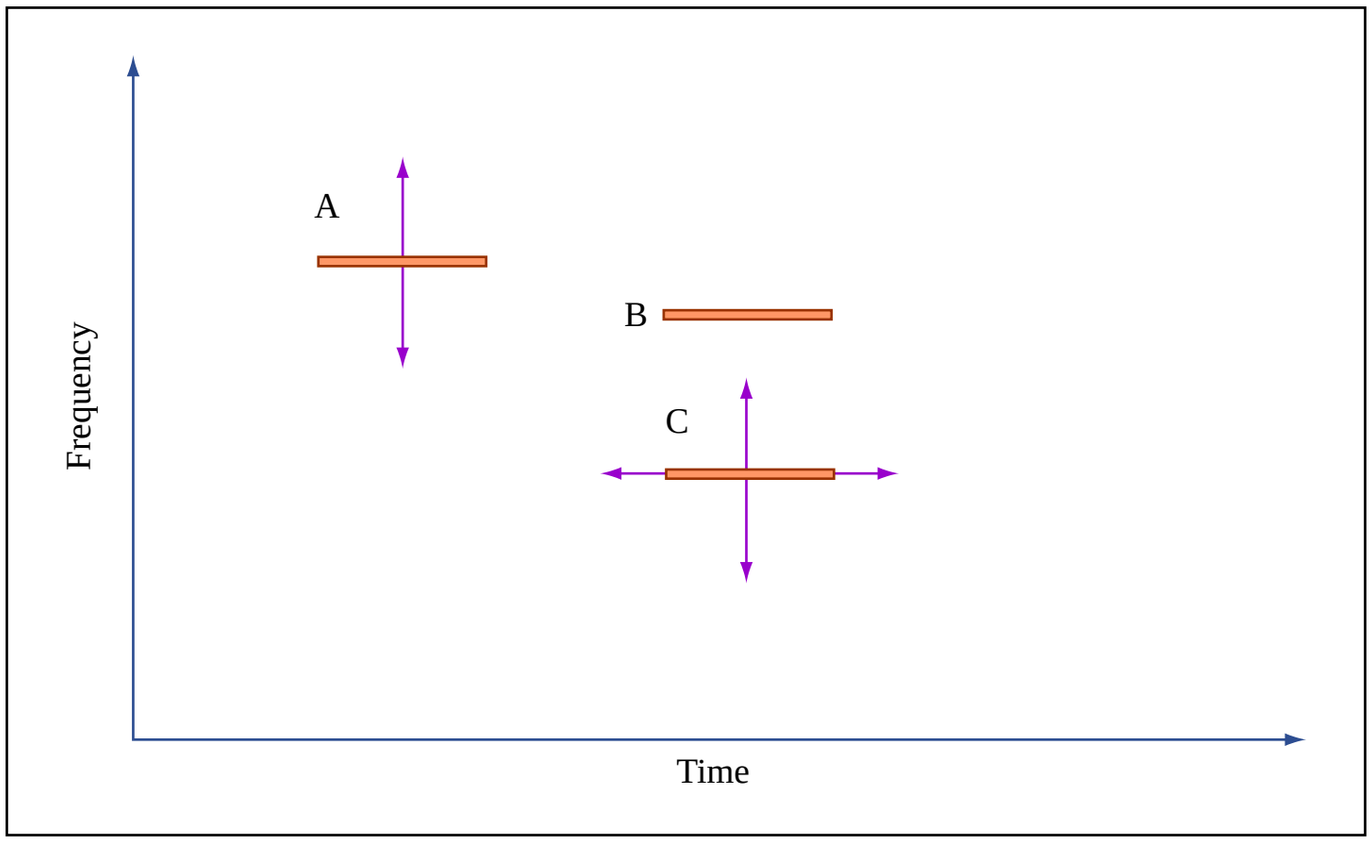


Figure by MIT OpenCourseWare.

Bregman and Pinker, 1978

Scale illusion

- Deutsch, 1975

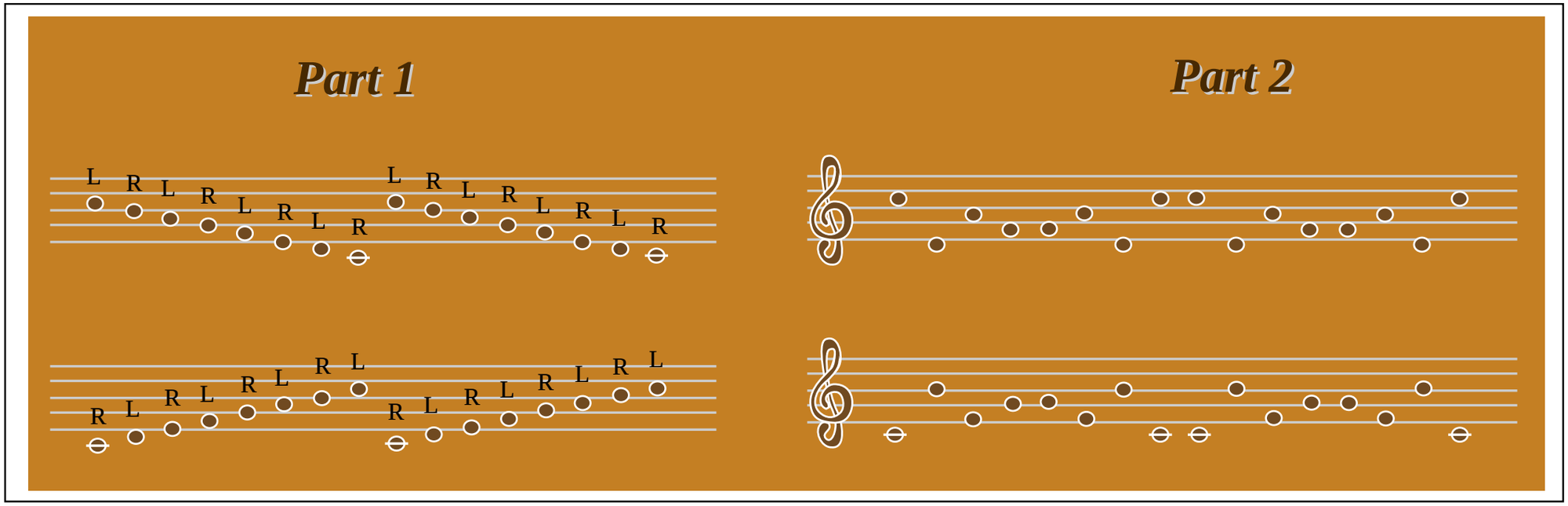


Figure by MIT OpenCourseWare.

Scale illusion

- Deutsch, 1975

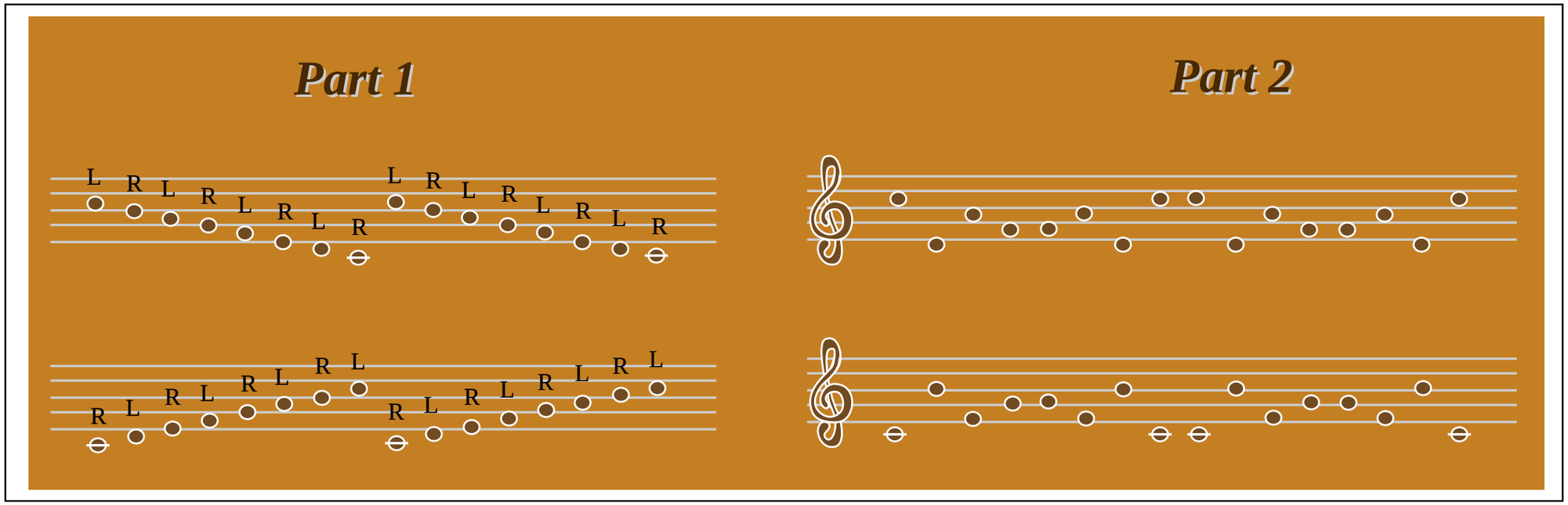


Figure by MIT OpenCourseWare.

Demo

Scale illusion

- Deutsch, 1975

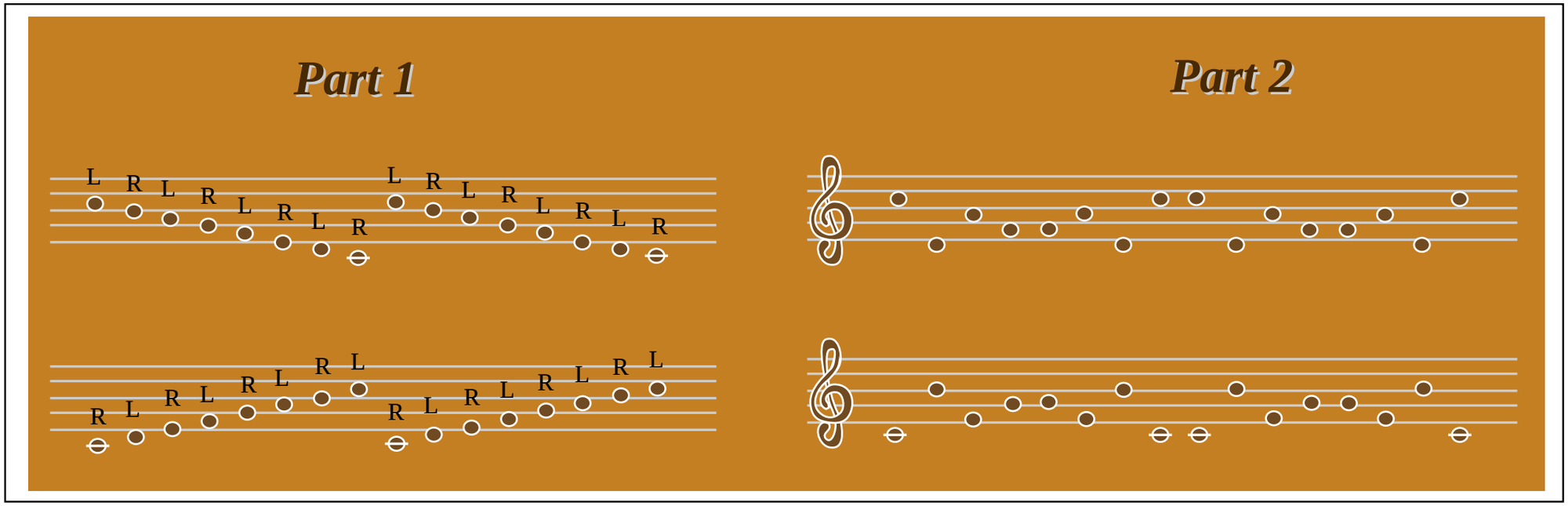


Figure by MIT OpenCourseWare.

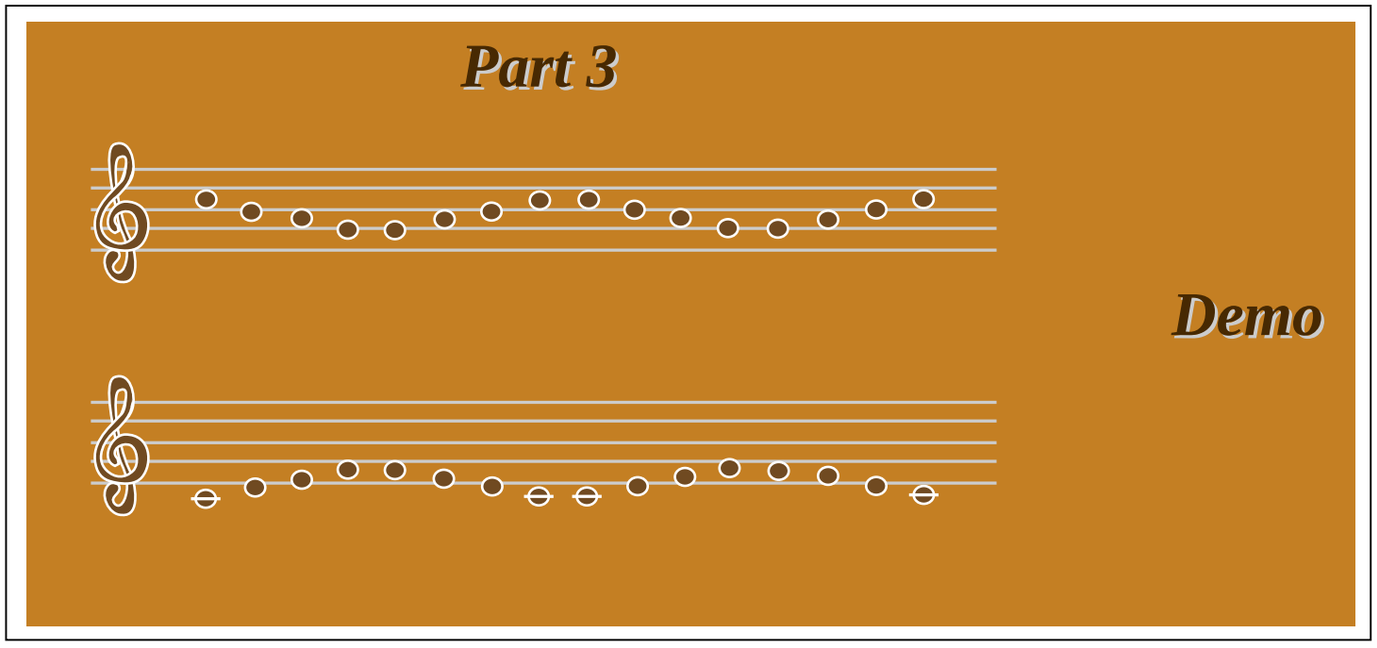


Figure by MIT OpenCourseWare.

Continuity

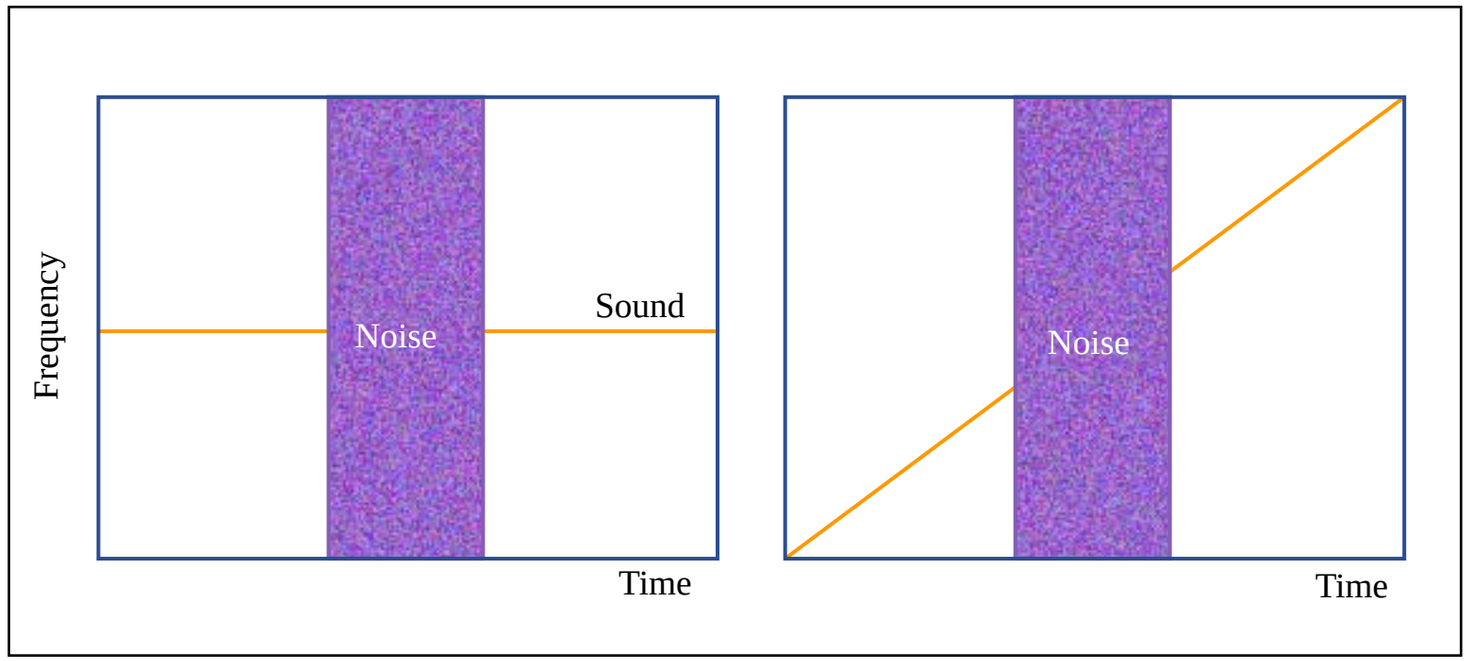
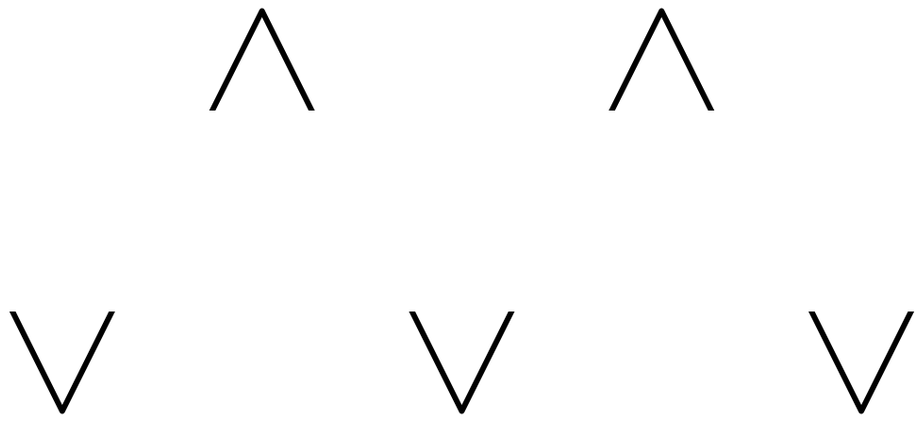


Figure by MIT OpenCourseWare.

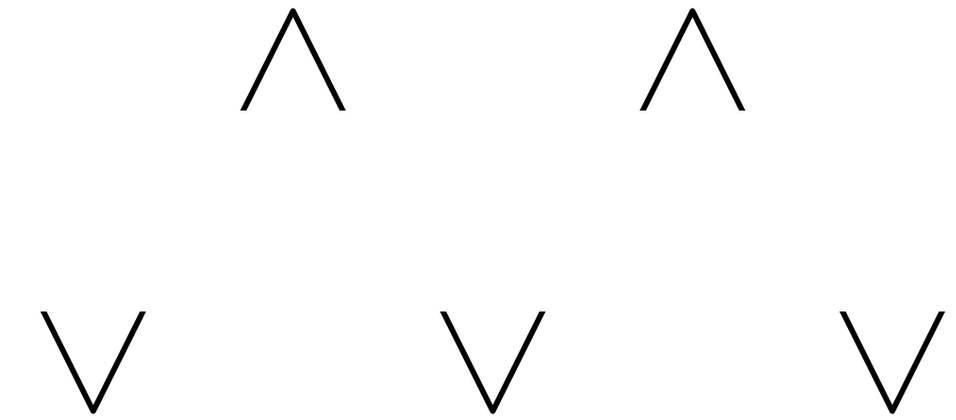
Kluender and Jenison 1992 - glides

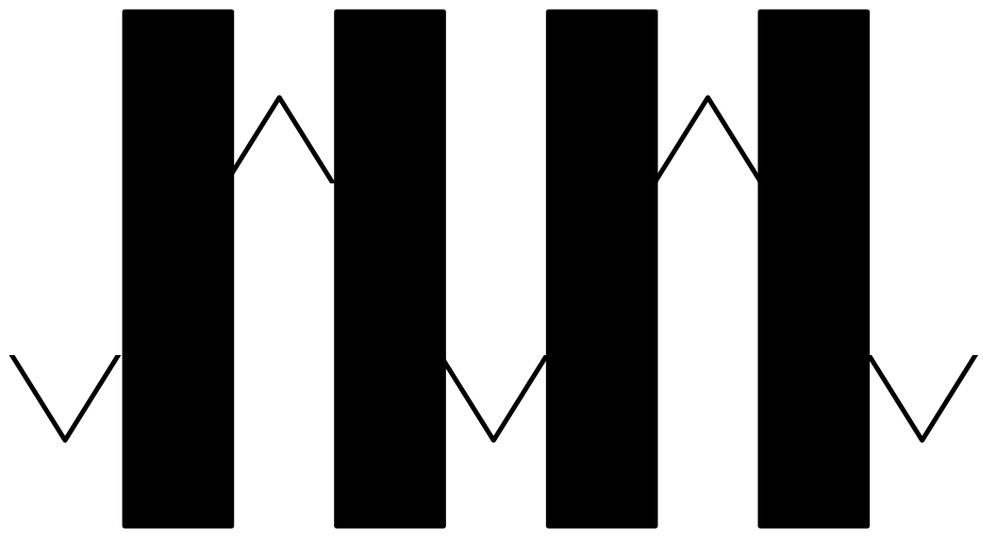
Continuity



adapted from Bregman, 1990

Continuity





adapted from Bregman, 1990

Restoration

- Sasaki (1980) - familiar piano melodies
- Warren and Sherman (1974)
  - the *eel fell off the car
  - The *eal fell off the table

Frequency Graphs

Figures removed due to copyright restrictions.

Melodies

Diana Deutsch, 1972

Melodies

Diana Deutsch, 1972

melody 1

Melodies

Diana Deutsch, 1972

melody 1

melody 2

Music

Music

guitar and sax

Music and Speech Perception

Kimo Johnson
April 29, 2008

Linguistic universals

- Discreteness
- Semanticity
- Arbitrariness
- Openness
- Duality of patterning

Hockett, 1963

Music grammars

- Discreteness: N pitches per octave
- Semanticity: scales, chords, keys
- Arbitrariness
- Openness
- Duality

Octave

- Frequency ratio 2:1
- Greatest number of identical overtones
- First overtone is 2 : 1

Sensory dissonance

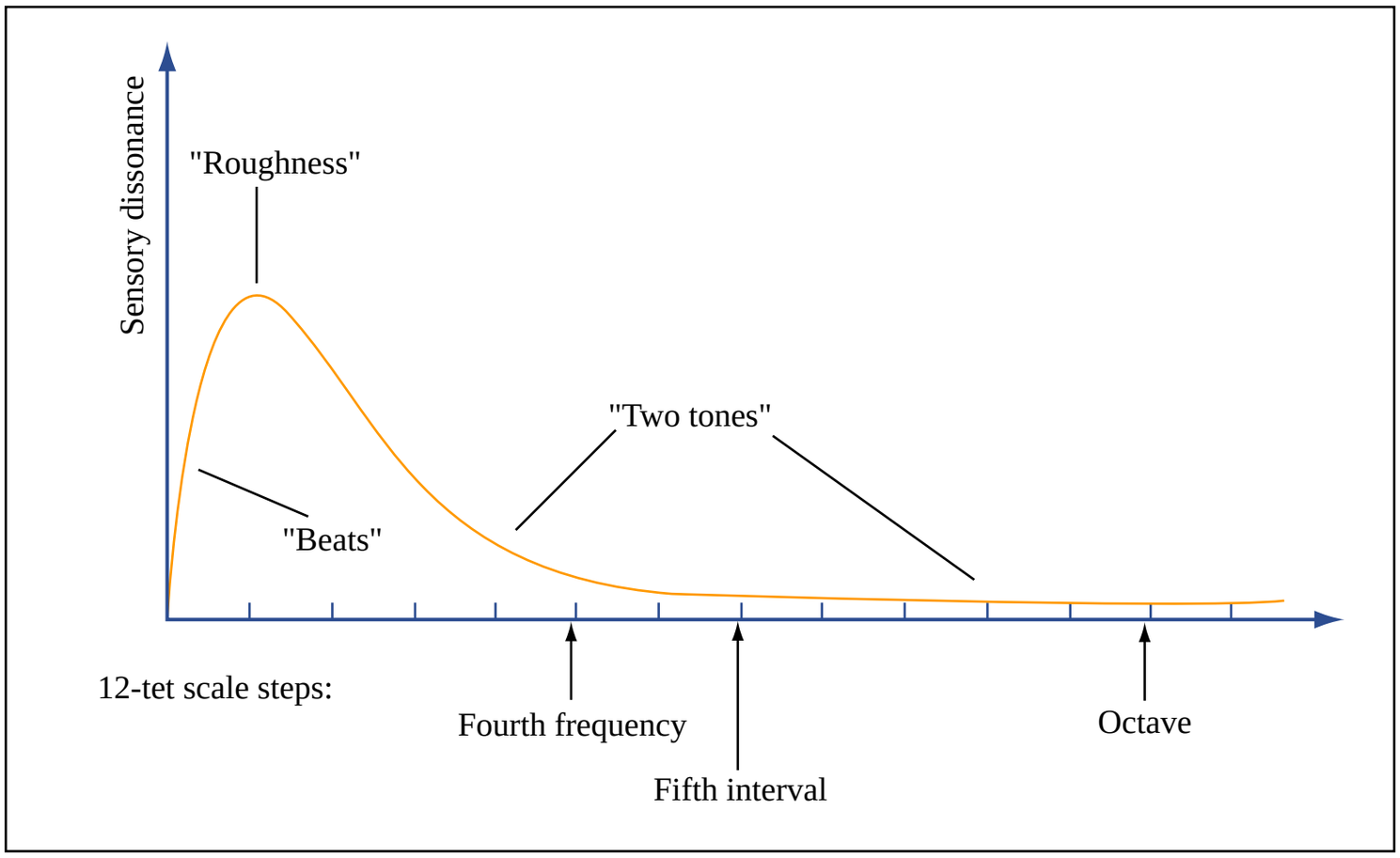


Figure by MIT OpenCourseWare.

Plomp and Levelt, 1965

Local consonance

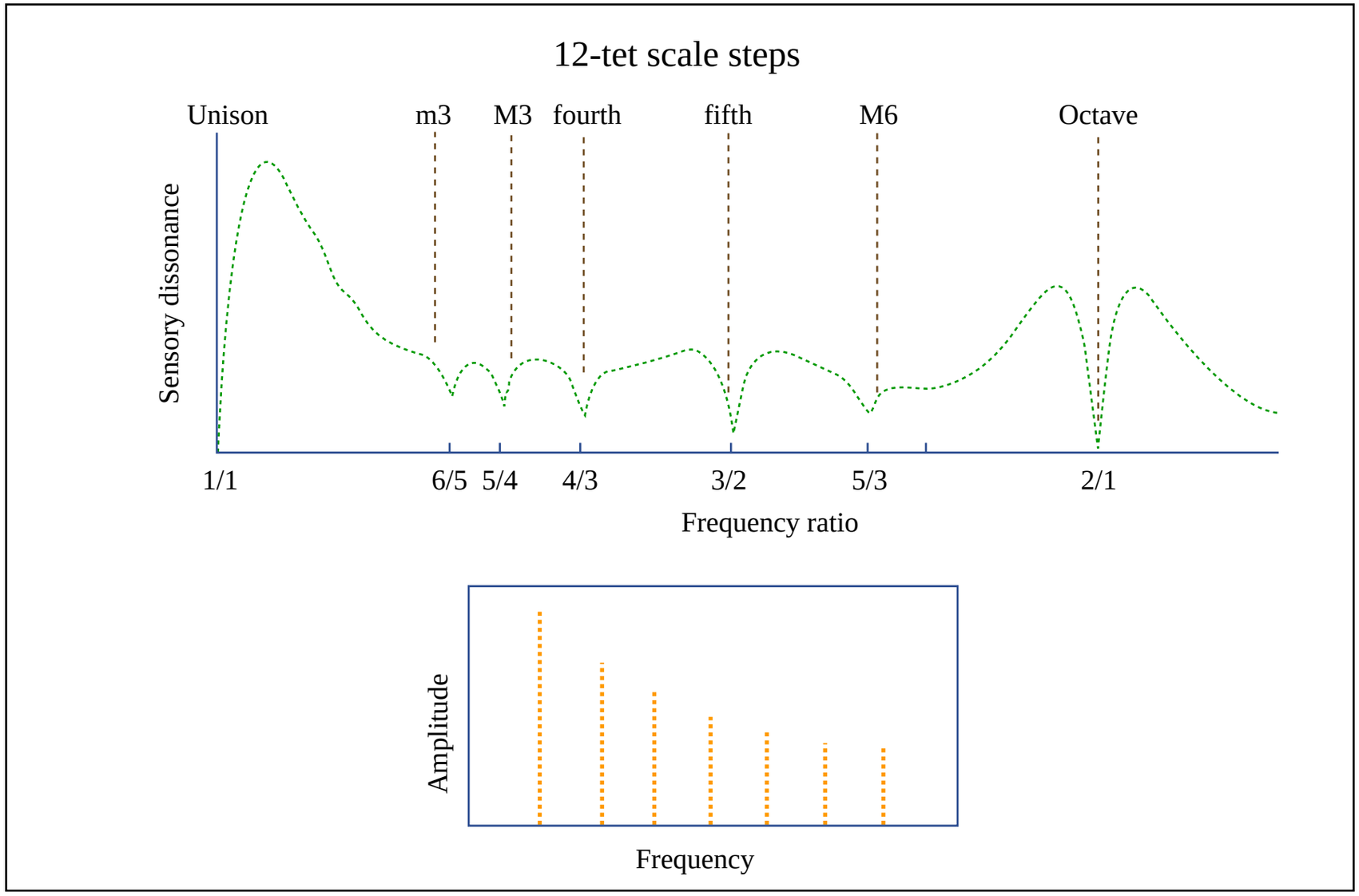


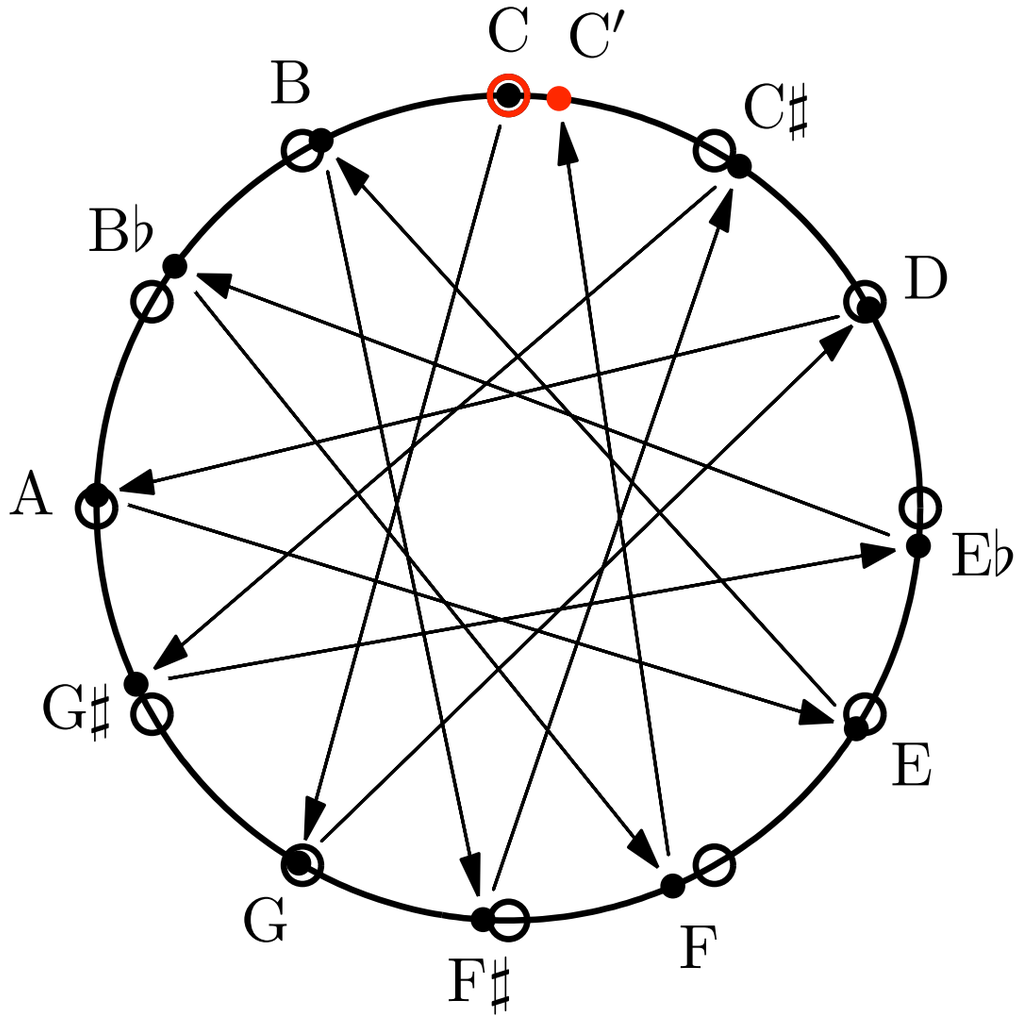
Figure by MIT OpenCourseWare.

Sethares, 1993

Pythagorean comma

$$f_1 = \frac{3}{2} f_0$$

$$f_i = \frac{3}{2} f_{i-1}$$



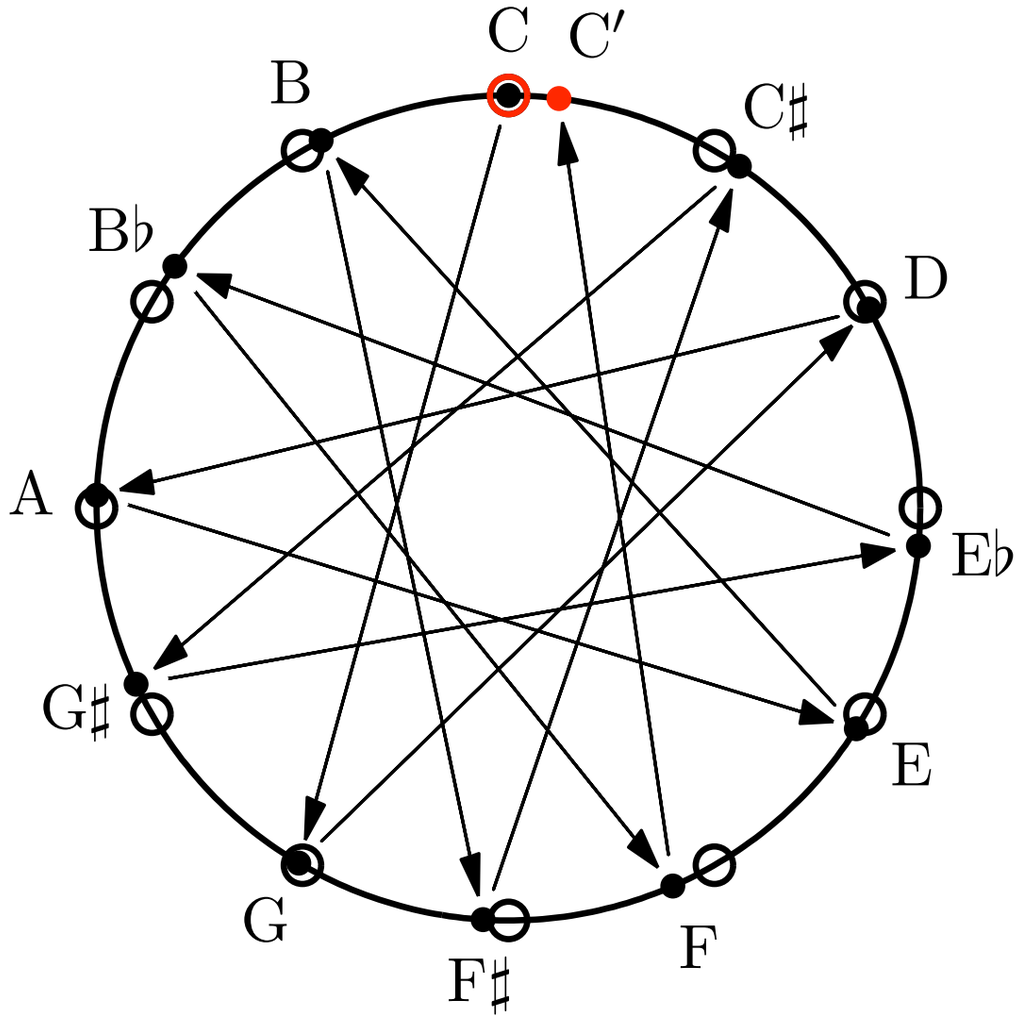
Pythagorean comma

$$f_1 = \frac{3}{2} f_0$$

$$f_i = \frac{3}{2} f_{i-1}$$

$$\left(\frac{3}{2}\right)^{12} \approx 2^7$$

$$\frac{3^{12}}{2^{19}} \approx 1.0136$$



Pythagorean tuning

C	C#	D	Eb	E	F	F#	G	G#	A	Bb	B
1/ 1	256/ 243	9/ 8	32/ 27	81/ 64	4/ 3	729/ 512	3/ 2	128/ 81	27/ 16	16/ 9	243/ 128

C : E = 81/64 = 1.2656
C : E = 5/4 = 1.25

C : Eb = 32/27 = 1.1852
C : Eb = 6/5 = 1.20

C# : F# = 1.3515 ≠ 1.333

Pythagorean tuning

C	C#	D	Eb	E	F	F#	G	G#	A	Bb	B
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C : E   = 81/64  = 1.2656
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C : Eb  = 32/27  = 1.1852
C : Eb  =  6/5   = 1.20

C# : F# = 1.3515 ≠ 1.333
```

wolf

Other tuning systems

- Just diatonic
- Meantone (1400)
- Well-temperaments
  - Werckmeister (1645-1706)
  - Young (1773-1829)
- Equal temperament (~1900)

Optimal well-temperament

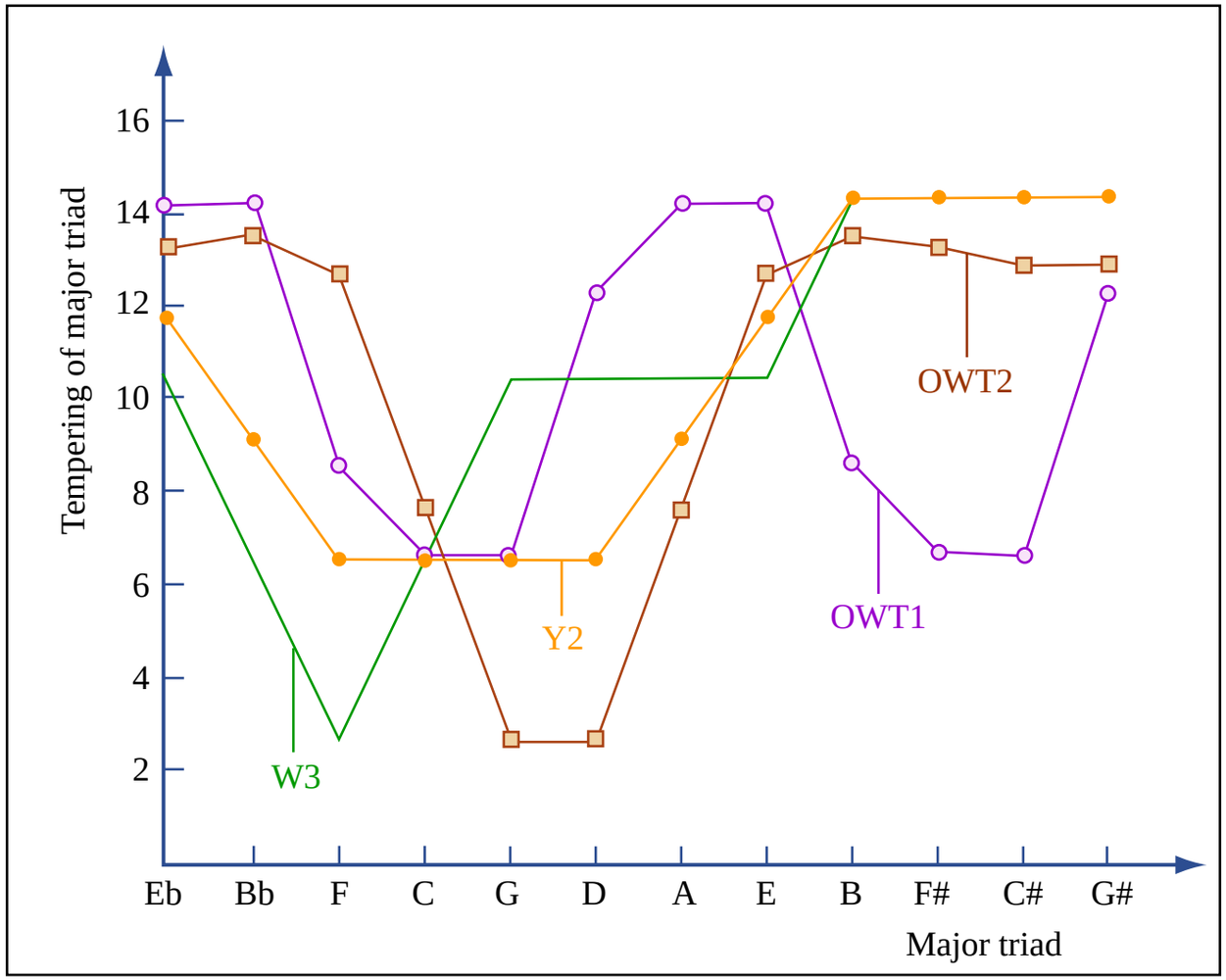

Figure by MIT OpenCourseWare.

Polansky et. al, 2008