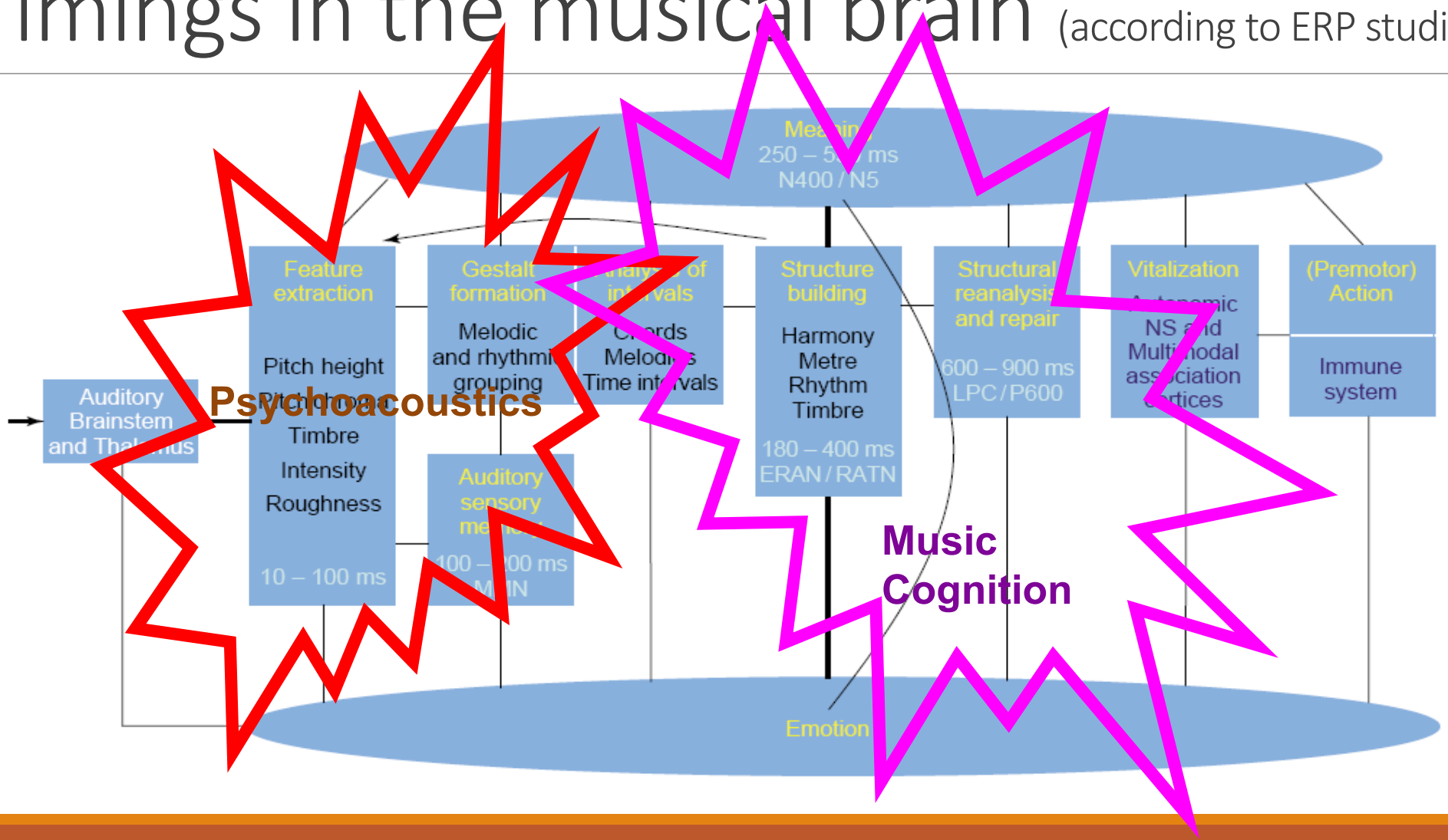
Perceptual organization

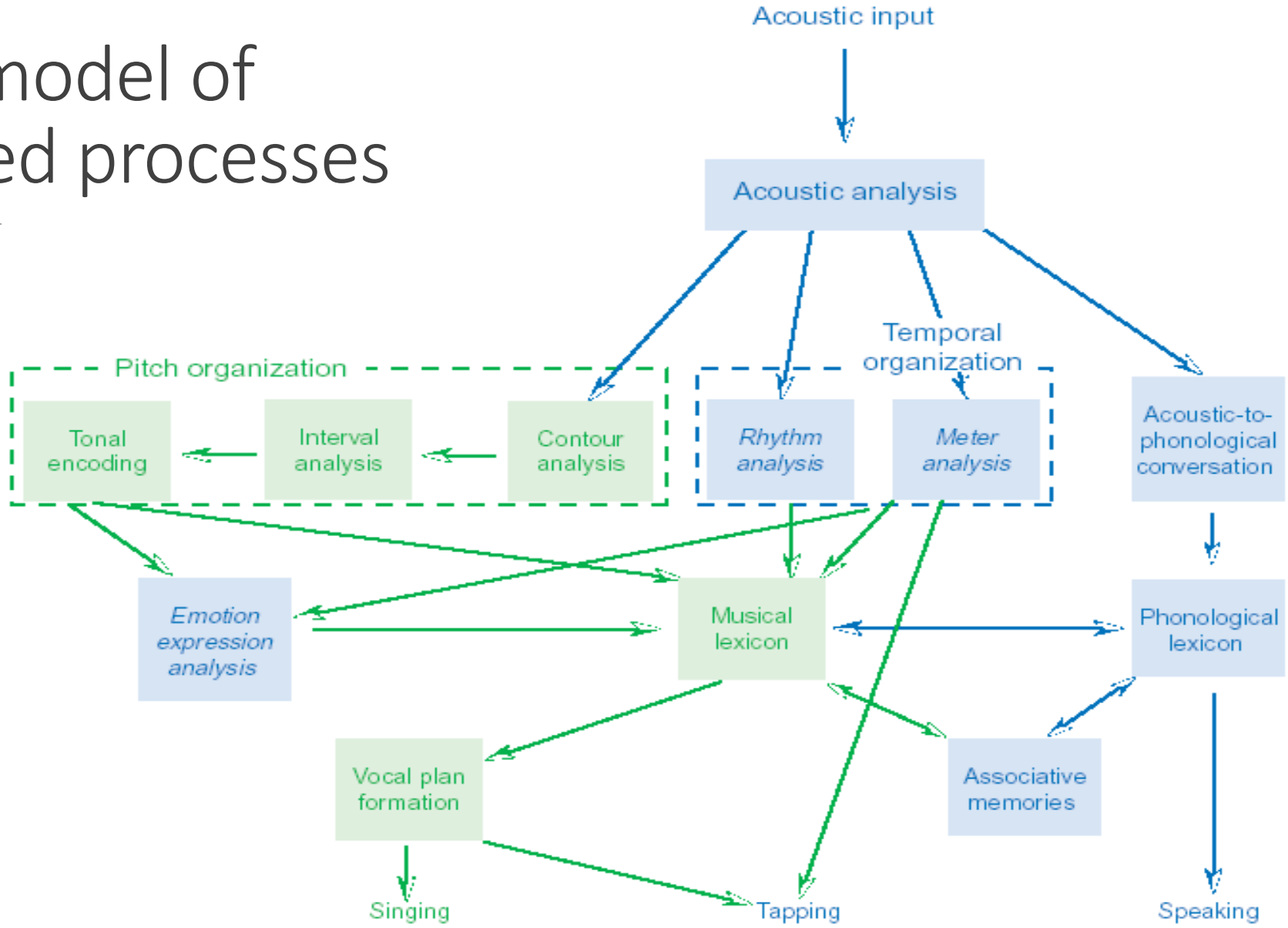
MAKING SENSE OF SONIC PATTERNS

Timings in the musical brain (according to ERP studies)



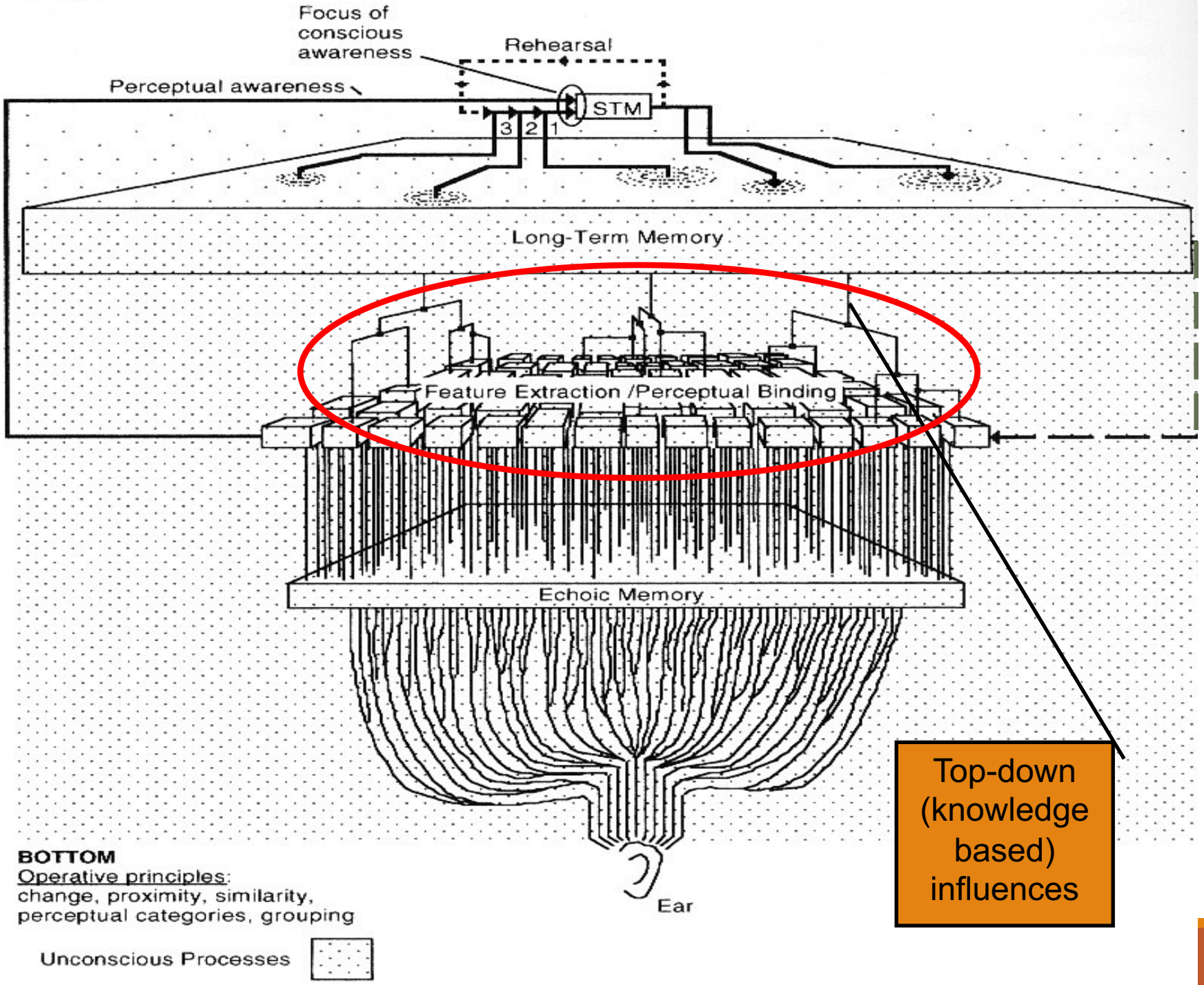
Koelsch & Siebel (2005). Towards a neural basis of music perception, Trends in Cognitive Sciences Vol.9 No.12.

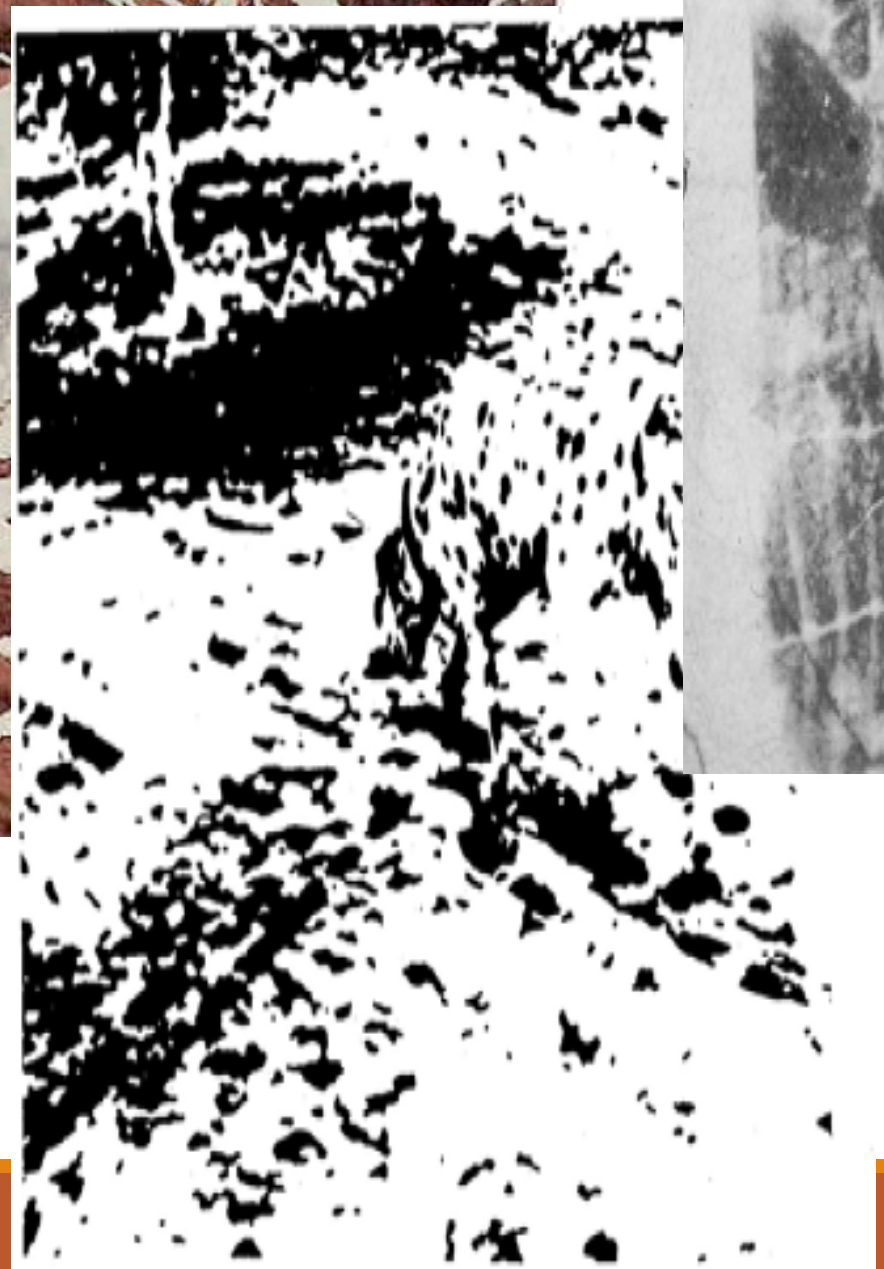
A graphical model of some involved processes

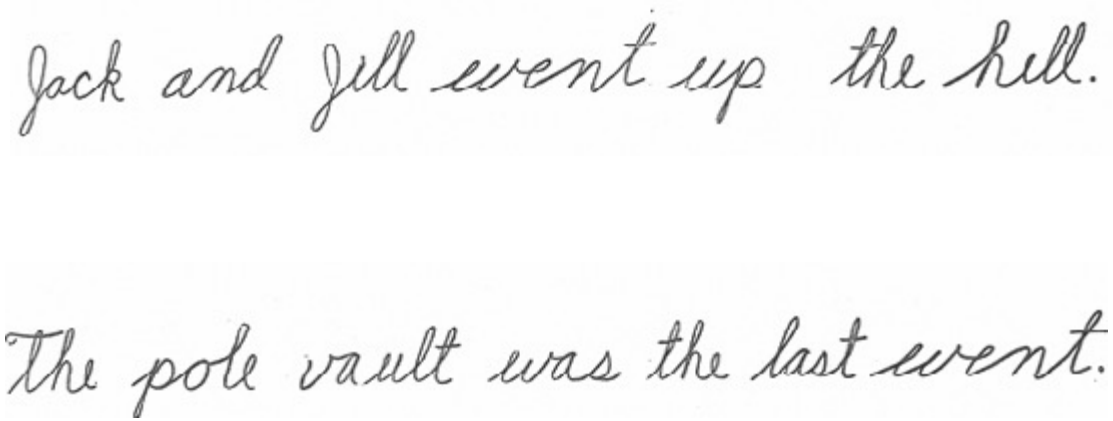


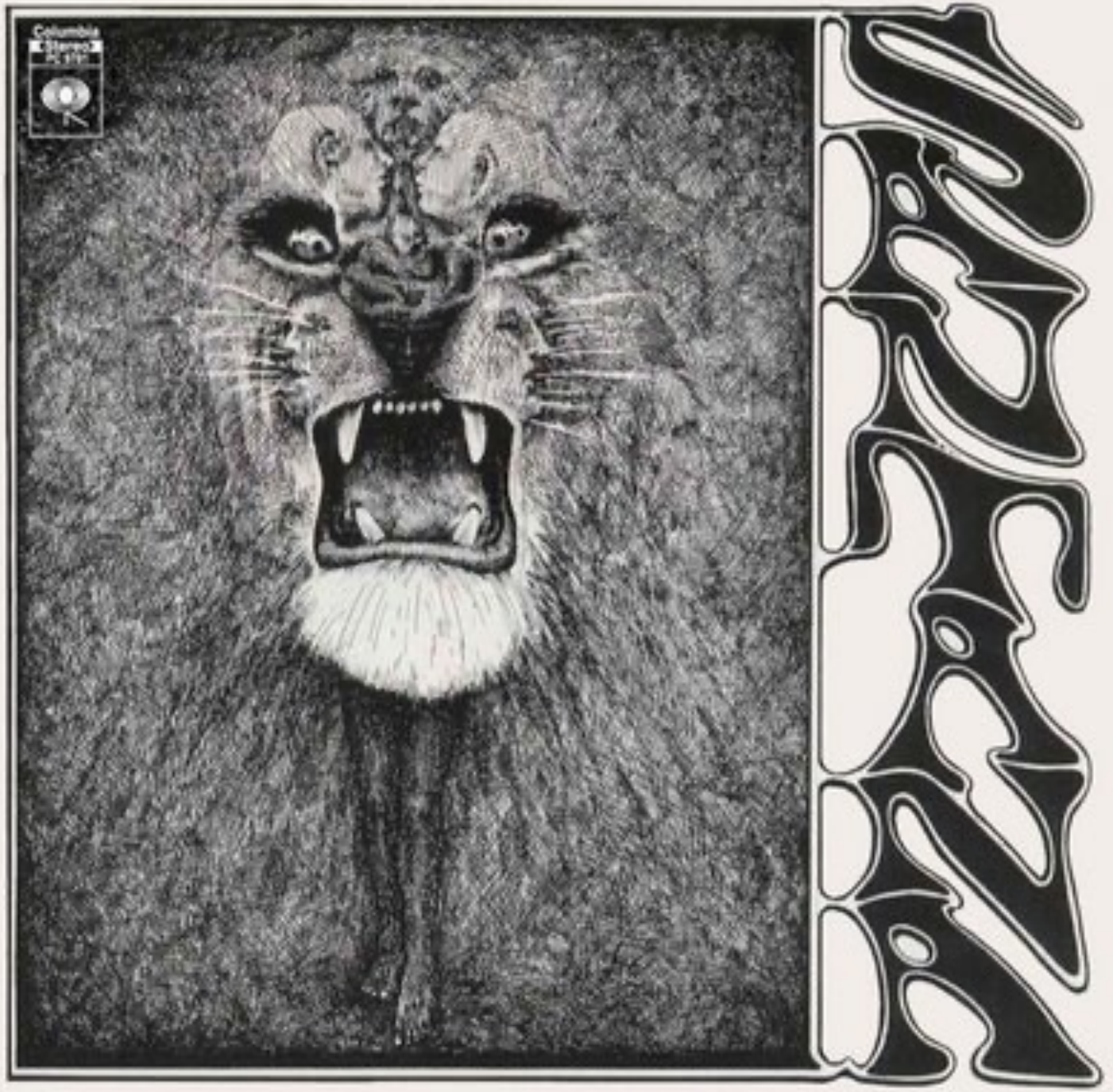
Peretz i Coltheart (2003), Modularity of music processing, Nature Neuroscience, 6(7)

Perceptual Binding






Jack and Jill went up the hill.
The pole vault was the last event.


Columbia
Stereo

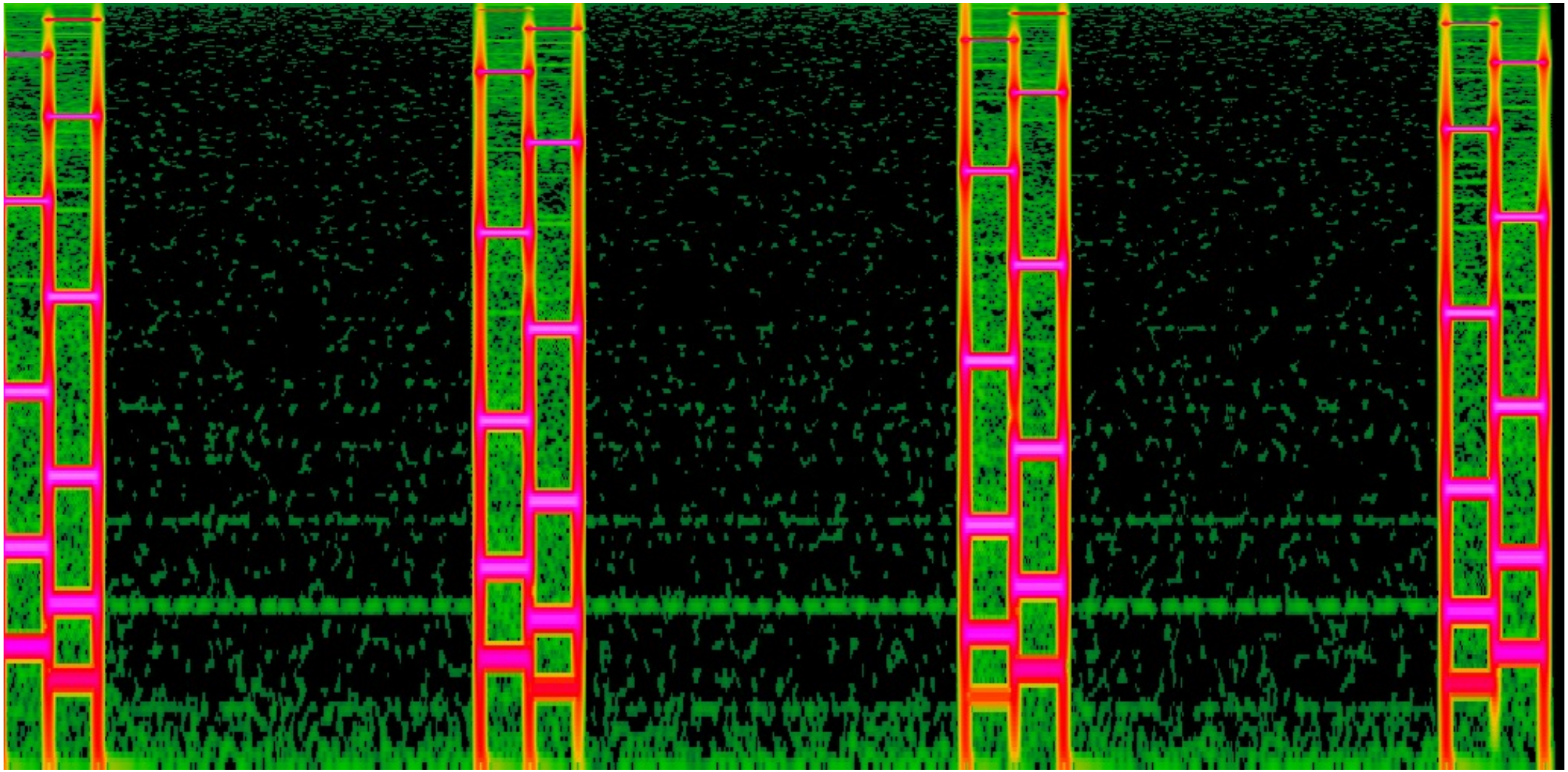
3 different sequences of tones

Can you perceive the second tone in each pair as ascending in pitch?

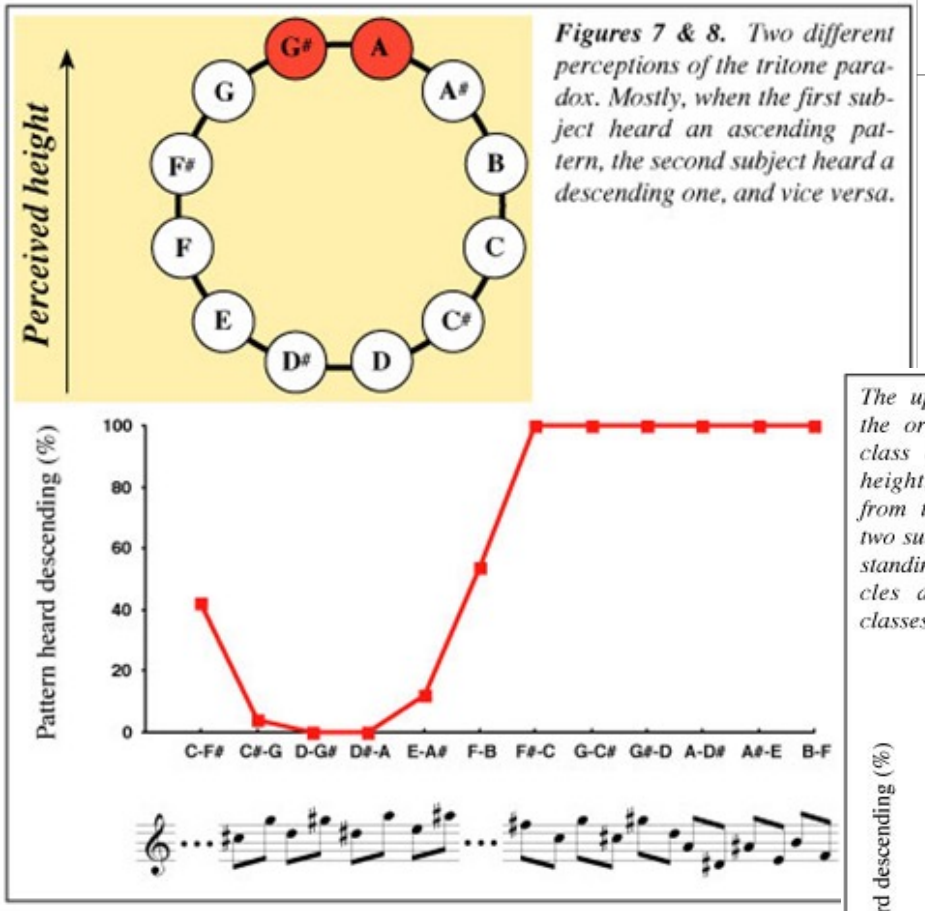
Can you perceive the second tone in each pair as descending in pitch?

What you do perceive?

Why the previous pairs of tones are ambiguous?



The tritone paradox



Figures 7 & 8. *Two different perceptions of the tritone paradox. Mostly, when the first subject heard an ascending pattern, the second subject heard a descending one, and vice versa.*

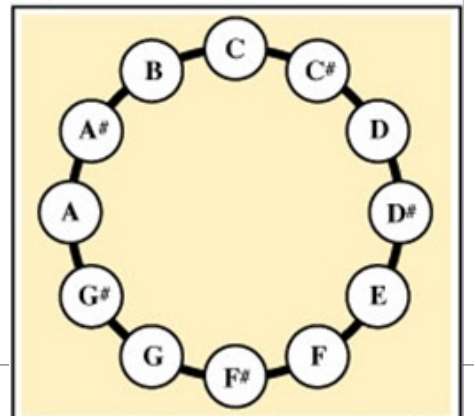
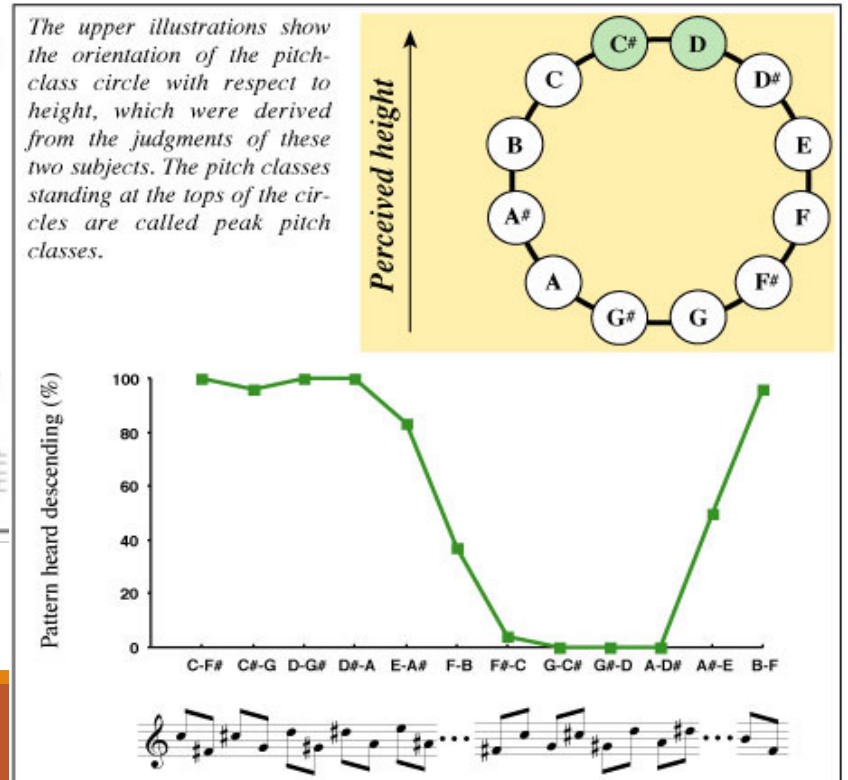


Figure 6. *The pitch-class circle. This corresponds to the twelve pitch classes within the octave. In the experiment demonstrating the tritone paradox, pairs of tones are played that are opposite each other along the circle, such as C followed by F#, or G# followed by D.*

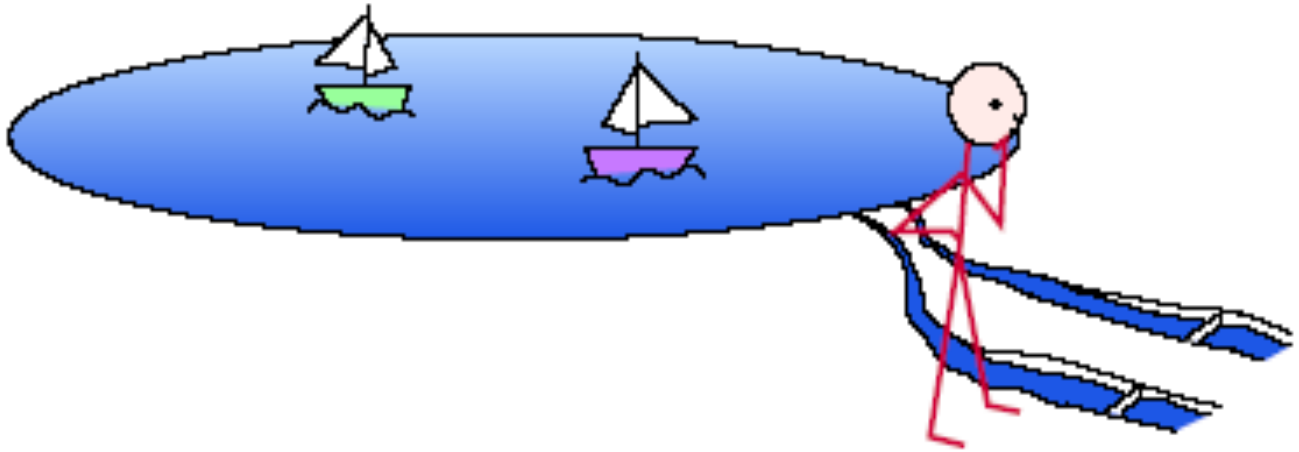
The upper illustrations show the orientation of the pitch-class circle with respect to height, which were derived from the judgments of these two subjects. The pitch classes standing at the tops of the circles are called peak pitch classes.



http://philomel.com/musical_illusions/tritone.php

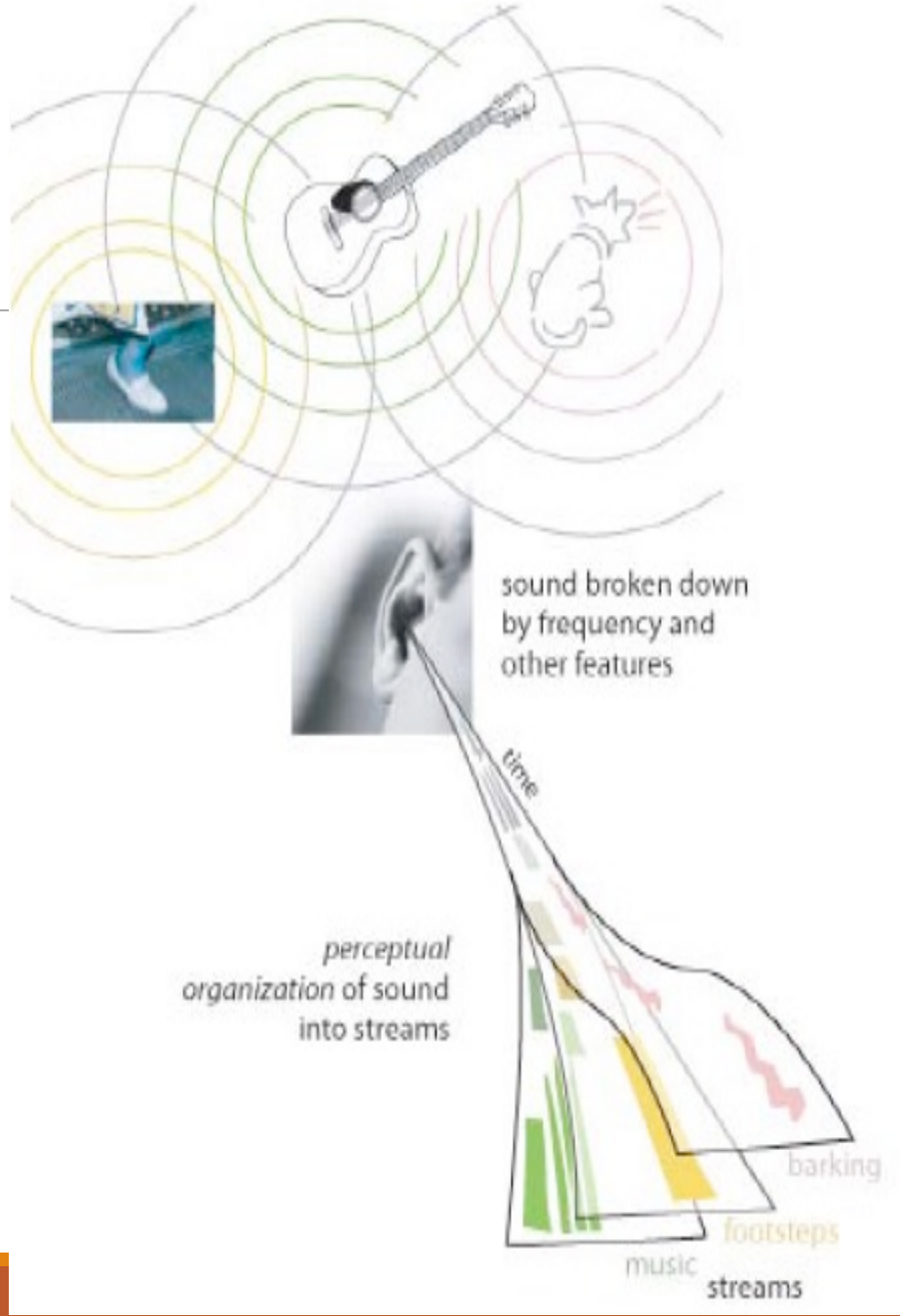
Audio-visual interactions: the McGurck effect

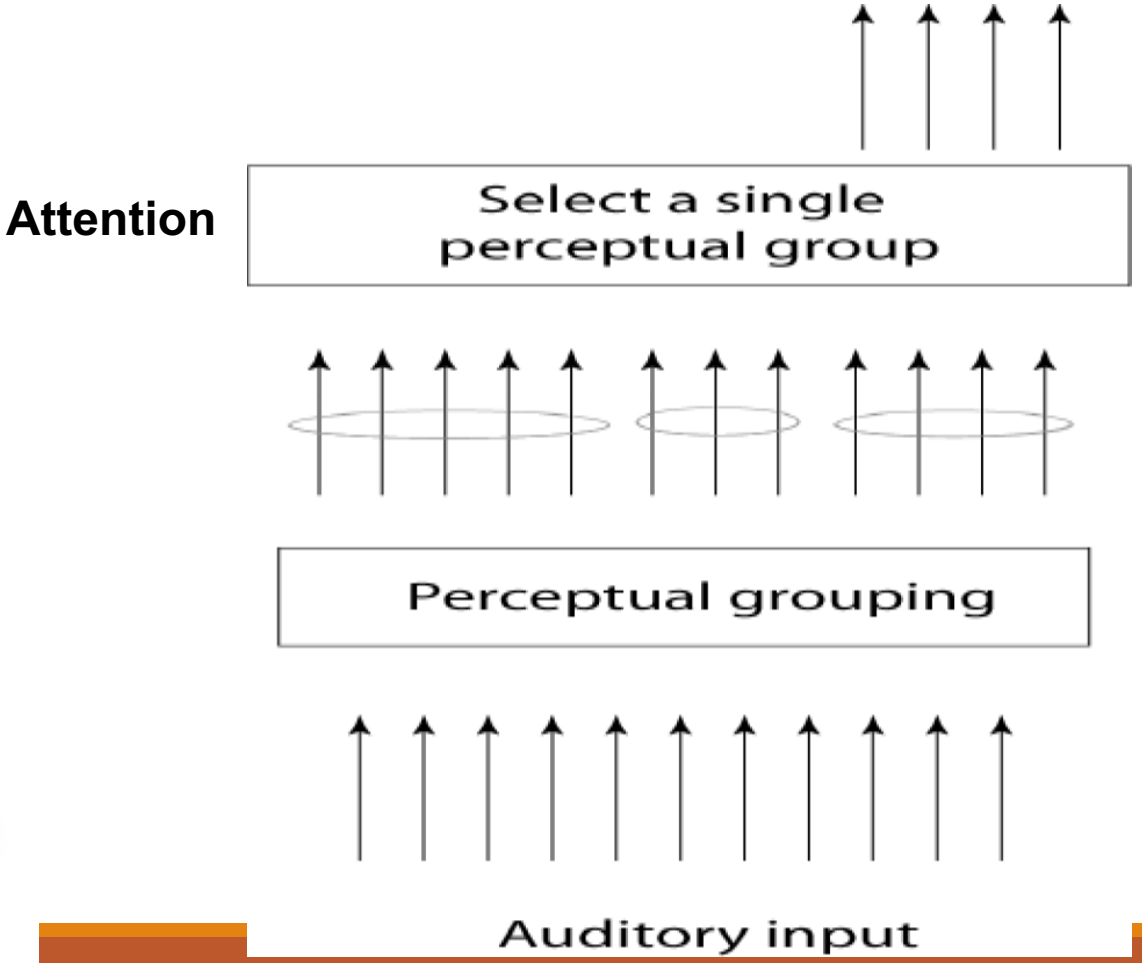
The problem(s) of perceptual organization



"Imagine two narrow channels dug up from the edge of a lake, with handkerchiefs stretched across each one. Looking only at the motion of the handkerchiefs, you are to answer questions such as: How many boats are there on the lake and where are they?" (after Bregman'90)

Perceptual Organization





Some terms

Source – the physical entity that gives rise to the sound pressure waves (e.g. a violin being played)

Stream – the percept of a group of successive and/or simultaneous sounds as a coherent whole appearing to come from a single source (e.g., the brass section)

The sounds we hear at any one time usually come from a number of different sources.

In most cases we can hear and identify each of the different sound sources as having its own pitch, timbre, loudness and location (stream=source). In other cases several sources are processed as a single stream as their features do not qualify for being considered as "distinct" (e.g., string section). In other –exotic- cases, a single source may yield different streams.

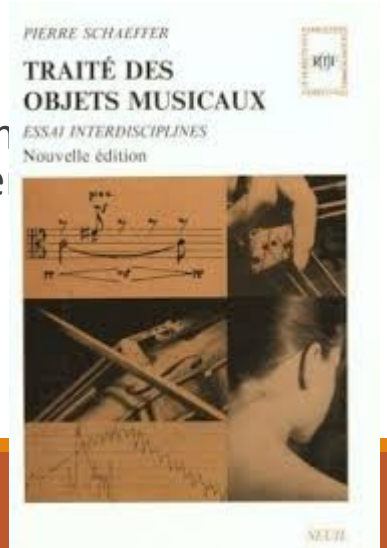
1- Bach: partita 2 in d minor bwv 1004 – ciaccona
2 - Gabon music: etudes de jodis
3 - Evan Parker: conic_section 4

Auditory Scene Analysis

ASA can be conceptualized as a two-stage process:

1. The mixture of sounds is decomposed into a collection of sensory elements (onsets, pitch trajectories, modulations, spectral tracks, etc.)
2. Elements that are likely to have arisen from the same event are grouped to form a perceptual structure (*stream)* which can be interpreted by higher centers in the brain

For example, when listening to a violin performance, it is the task scene analysis to group the acoustic events emitted from the ph source (the violin) into a perceptual stream (the mental experie violin being played).



Is this the only way of listening? What about “reduced listening”?

Read Pierre Schaeffer

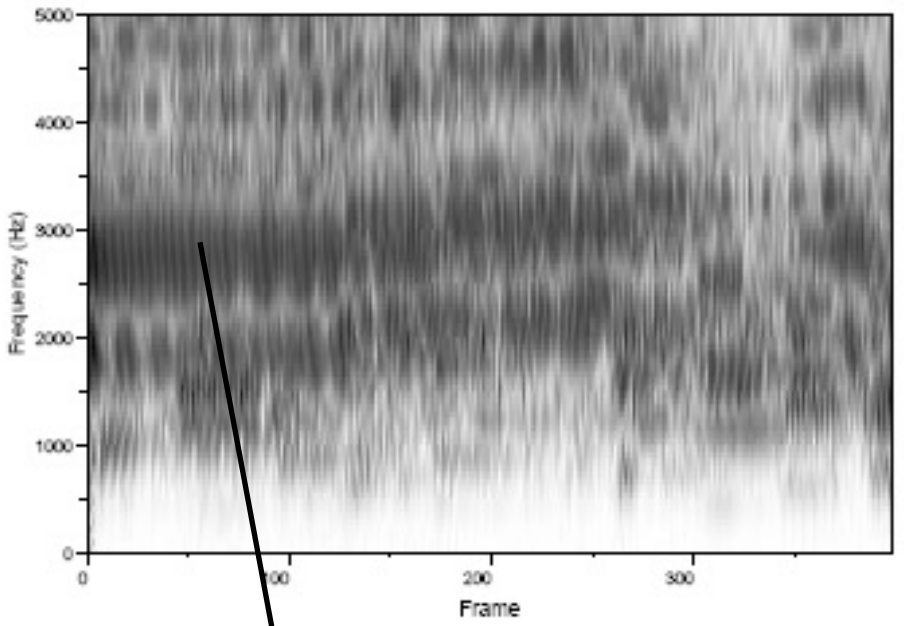
Auditory Scene Analysis

In most listening situations, a mixture of sounds reaches the ears. However we can:

- Attend to one conversation amid many competing voices and other background sounds (e.g. music) at a ‘cocktail party’
- Follow the melodic line played by the violins in an orchestral recording.

This problem is of great scientific interest, and a solution also has engineering applications

-> The Holy Grail!!!



“Auditory image” of Bach’s Mass in Bm, consisting of voice, violin, cello etc.

How does the auditory system process this image to recover a description of each source?

The Figure-Ground Phenomenon

- Attention to one stream at a time
- Attending to one conversation at a time at a party
- Attending to a soloist in a concert
- Attending to TV at noisy home

Listeners' attention usually drawn to aspects of the sound that are changing – they become figure while the relatively unchanging part(s) become background

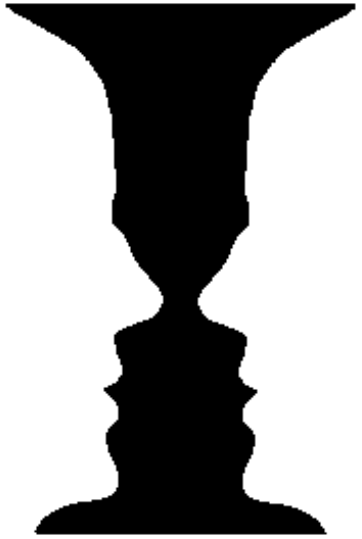
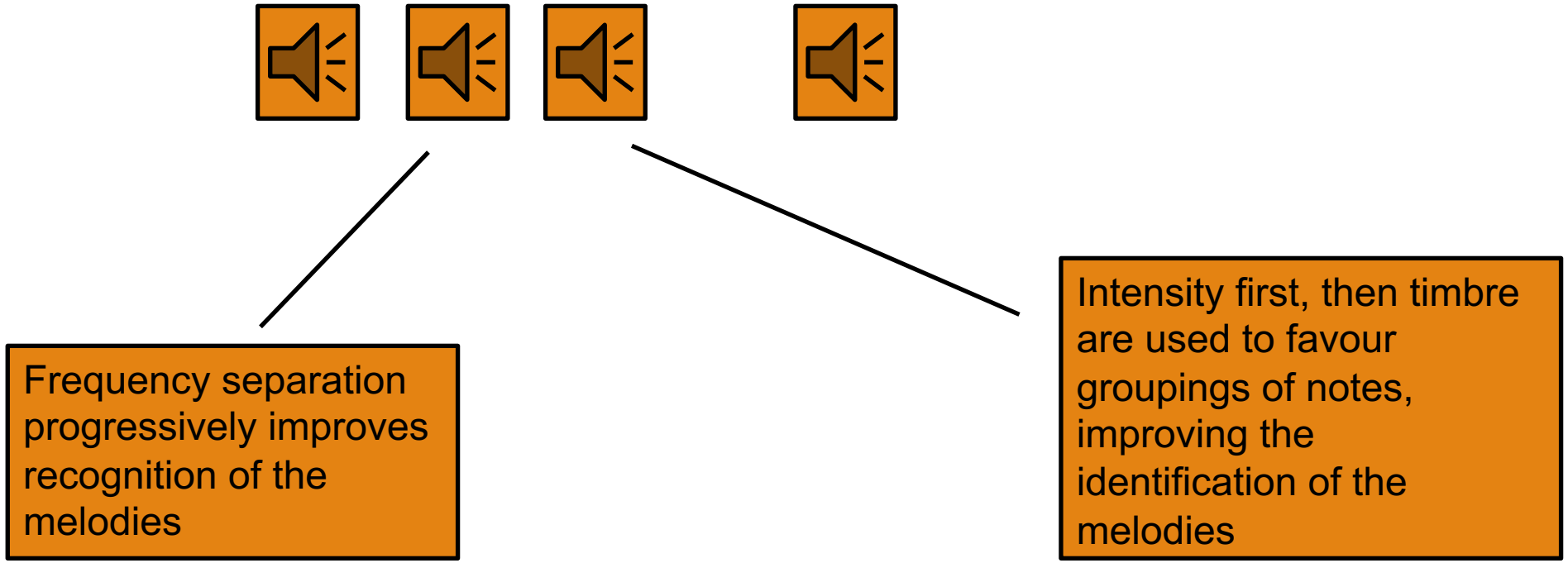


Figure-ground: Scrambled melodies

What should be foreground and what should be background in order to make the melody standing out?



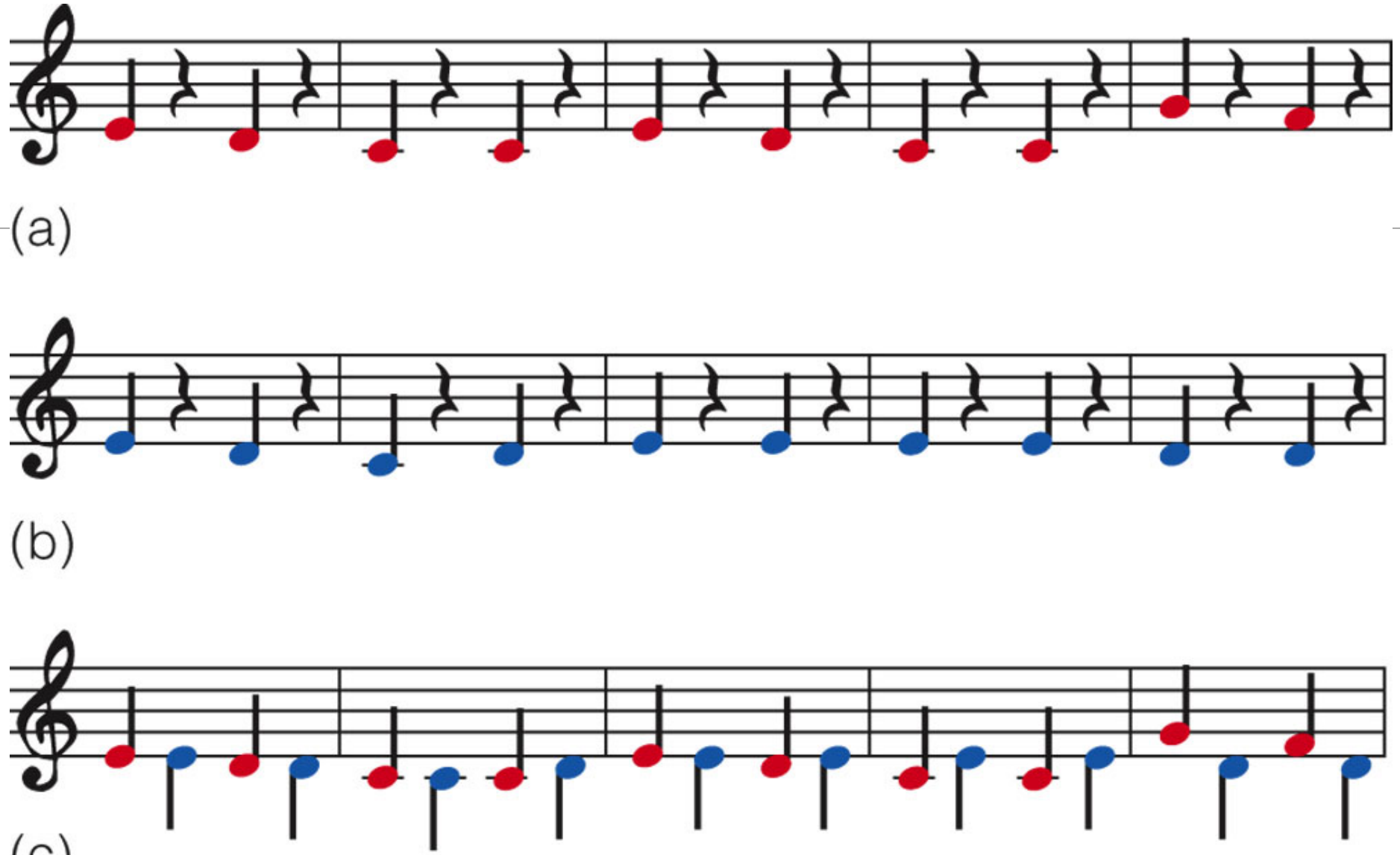
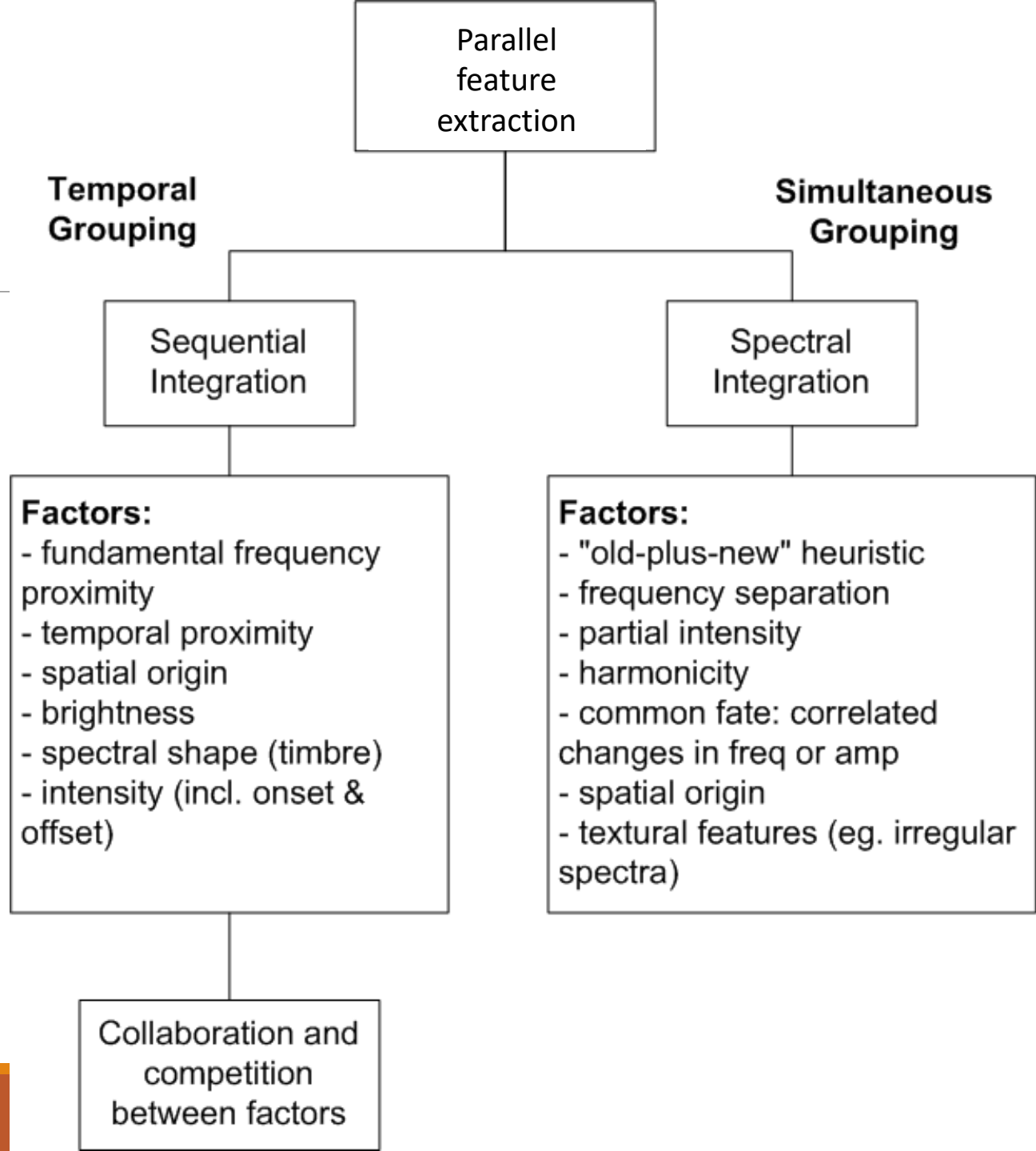


Figure 12.21 (a) “Three Blind Mice,” (b) “Mary Had a Little Lamb,” and (c) the two melodies interleaved (“Three Blind Mice: red notes, stems up; “Mary Had a Little Lamb”: blue notes, stems down).

Grouping heuristics

Simultaneous grouping – the grouping together of the simultaneous frequency components that come from a single source

Sequential grouping – the connecting over time of the changing frequencies that a single source produces from one moment to the next



A description of auditory and visual Gestalt Laws.

Name	Audition	Vision
Proximity (Belongingness)	Sounds arriving from places *close in space* tend to be grouped	Elements *close together* in space tend to be grouped
Similarity	Sounds with *similar timbre and pitch* tend to be grouped	Elements *shaped alike* tend to be grouped
Good Continuation	Sounds that follow a *regular pitch contour* tend to be grouped	Elements that follow a *regular spatial contour* tend to be grouped
Closure	Interrupted auditory stimuli tend to be perceived as *continuous* when plausible	*Borders are interpreted/completed* to specify shapes
Simplicity (Pragnanz)	Frequencies with *simple harmonic ratios* tend to be grouped	*Prototypical* shapes tend to be regular, simple, symmetric
Common Fate	Sounds with *synchronous rhythm patterns* tend to be grouped	Elements that *move together* tend to be grouped

Proximity

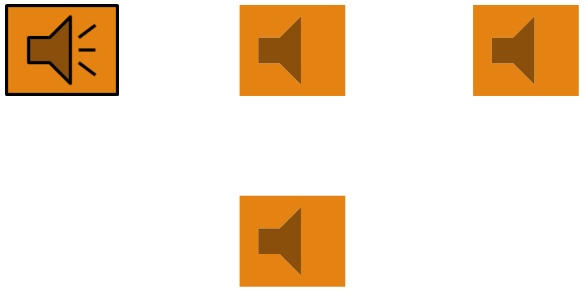
Stream segregation depends on proximities (temporal, pitch, etc.)

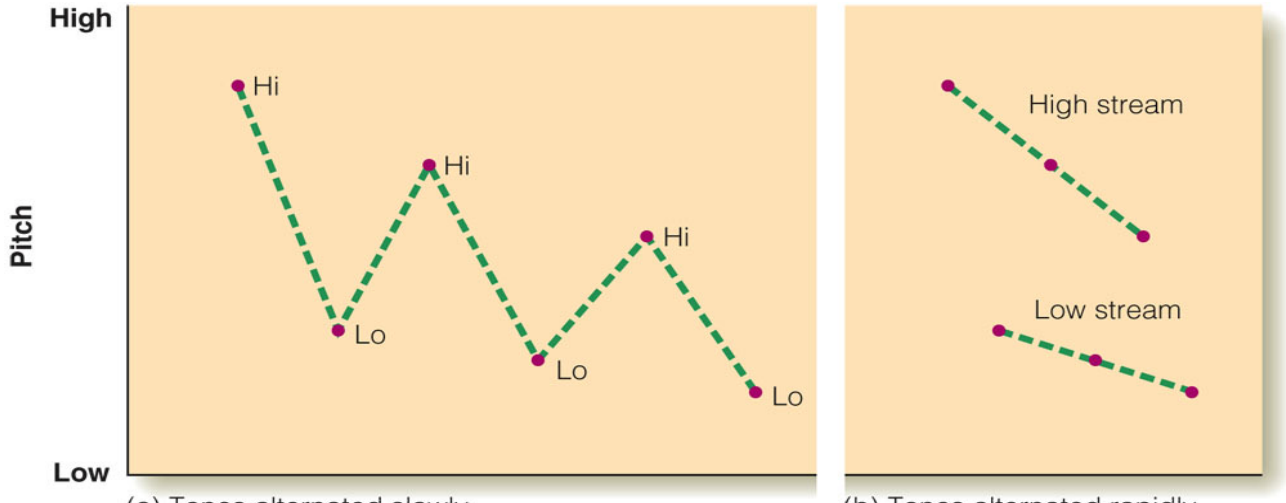
When stream segregation occurs, we are unable to attend fully to the events in both streams at the same time

-> Figure-background phenomena

-> Rhythmic confusions

-> Bi-stability





(a) Tones alternated slowly
Perception: Hi-Lo-Hi-Lo-Hi-Lo

(b) Tones alternated rapidly
Perception: Two separate streams

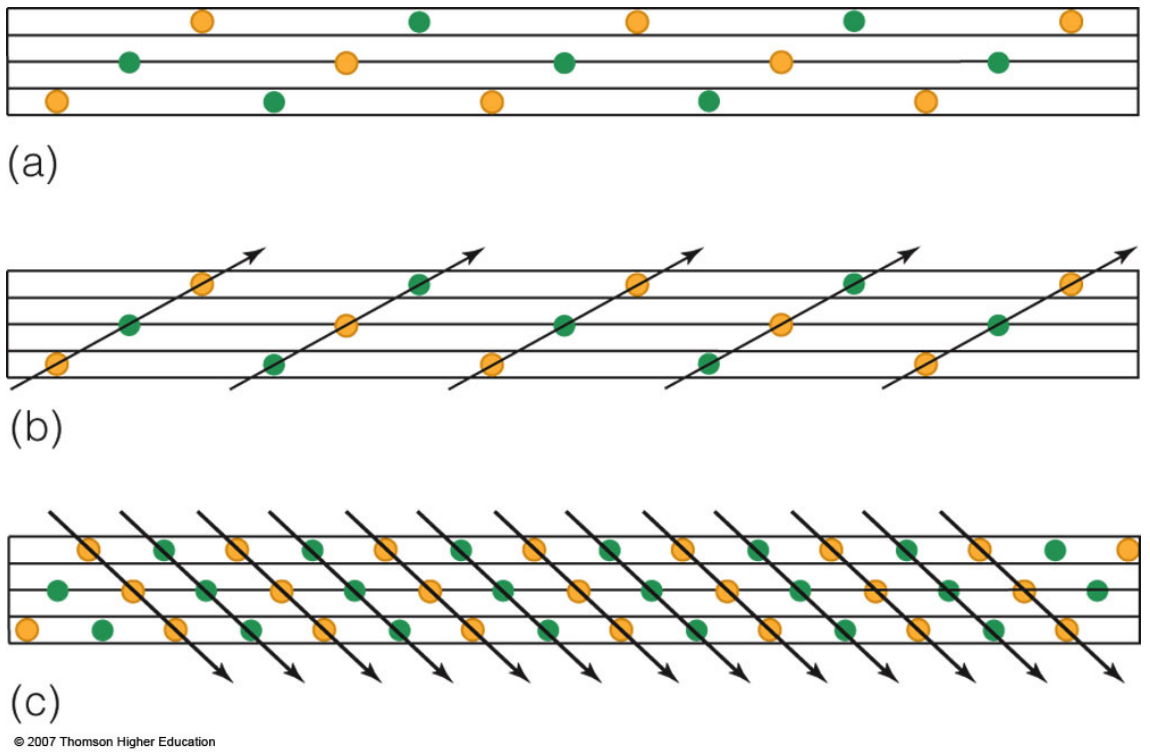
When high and low tones are alternated slowly, auditory stream segregation does not occur, so the listener perceives alternating high and low tones. (b) Faster alternation results in segregation into high and low streams.

Wessel's illusion

(a) The repeating series of three notes presented by Wessel (1979). The yellow circles stand for a tone with one timbre, and the green circles for a tone with a different timbre.

(b) When the tones are presented slowly, they are perceived as ascending sequences of notes that alternate in timbre.

(c) When the tones are presented rapidly, they are perceived as descending sequences of notes with the same timbre. This is Wessel's (1979) timbre illusion.



http://vimeo.com/83416183

Common Fate

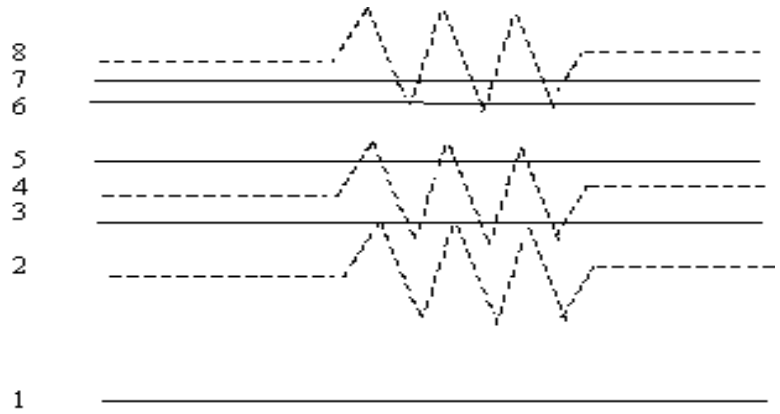
Components in sound act together

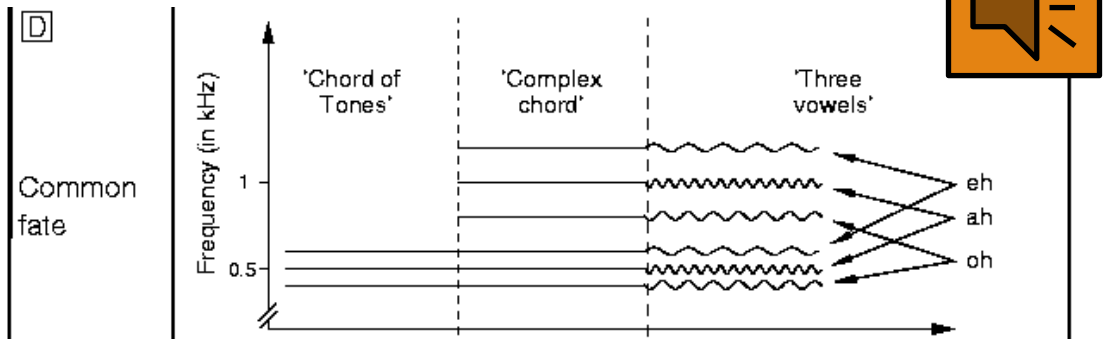
They tend to start and finish together

They tend to change in pitch or intensity together

Therefore if we have a complex sound and the components are co-ordinated then they are fused, e.g. onset disparities, and AM and FM (tremolo & vibrato)

For example if harmonics 2,4 and 8's frequency is modulated (FM) they separate from harmonics 3,5,6 and 7



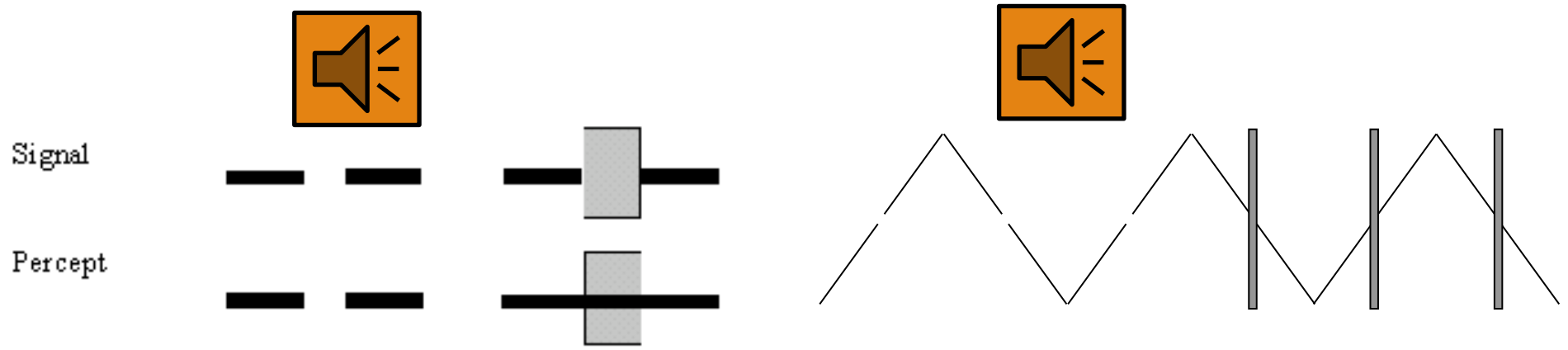


Closure

A source maybe obscured or absent – but its percept continues

Drums occlude long notes, but we don't worry about that!

In speech this is known as "phoneme restoration"



Bach’s musical offering:
masterful composition for efficient auditory streaming