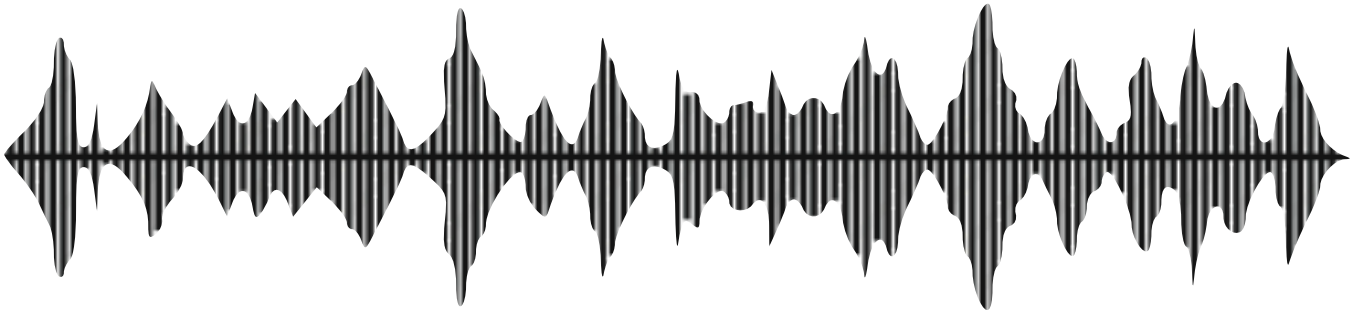
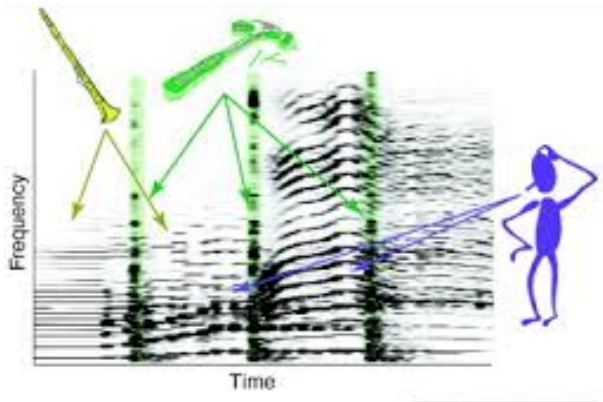
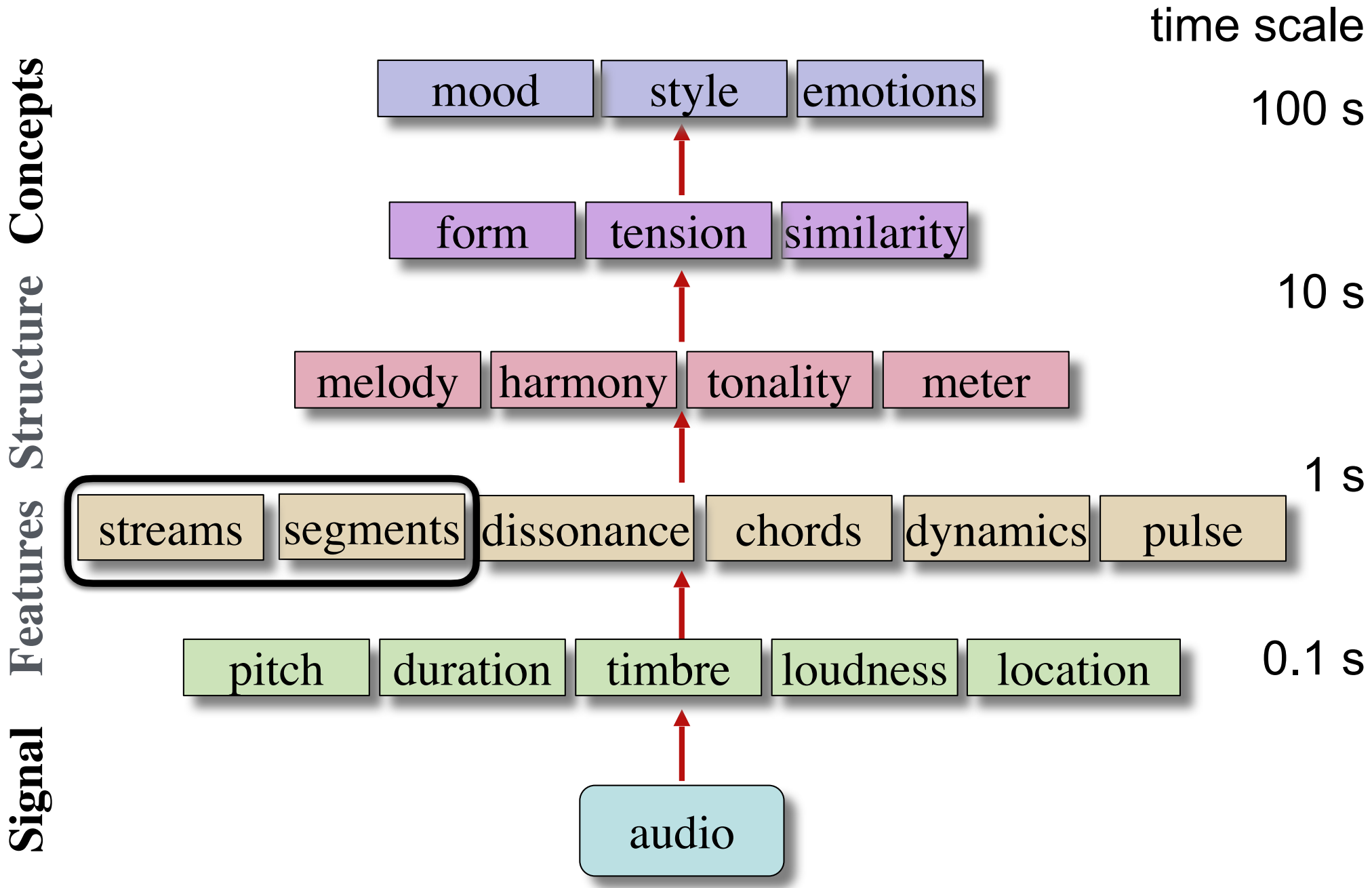


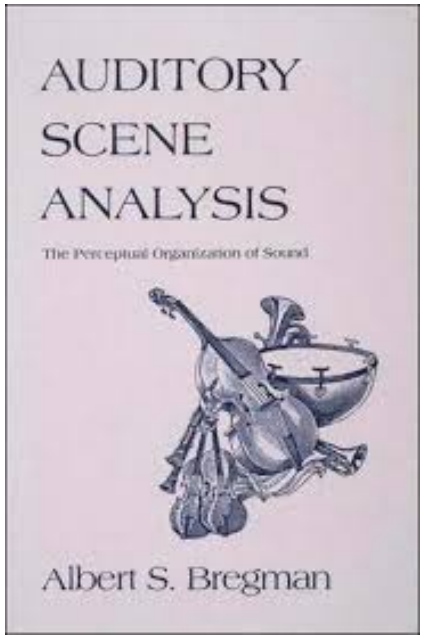

Frequency
Time

How many violins/violinists/streams do you hear?

3:40 **4:29** **6:56**

Levels of Music Processing

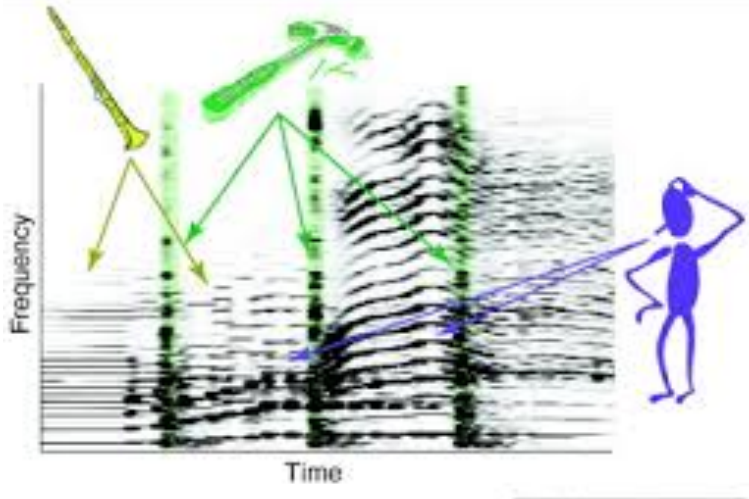


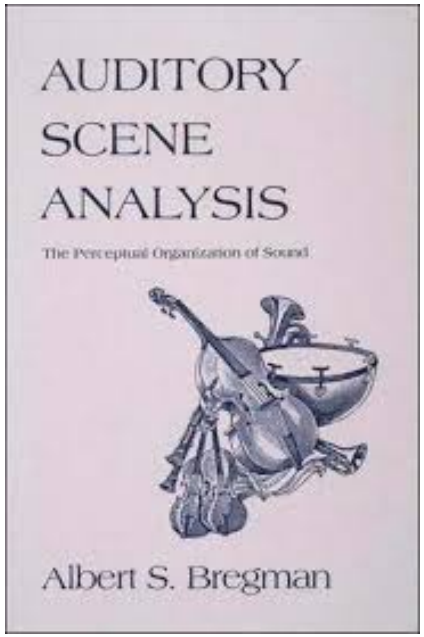


Perception and Perceptual Organisation

Auditory scene analysis

- coined by **Albert Bregman**
  - proposed model for the basis of auditory perception - the auditory system needs to make sense of the superposition of component sounds (**the auditory scene).**
  - human auditory system segregates and organizes sound into perceptually meaningful elements or **auditory streams** from an incoming mixed stream
  - it needs to group the components of the sound that come from the same sound source
  - ability to determine **location** and **distance** of sound
  - many of these can be explained by auditory analogues of the **Gestalt principles**





Gestalt Theory

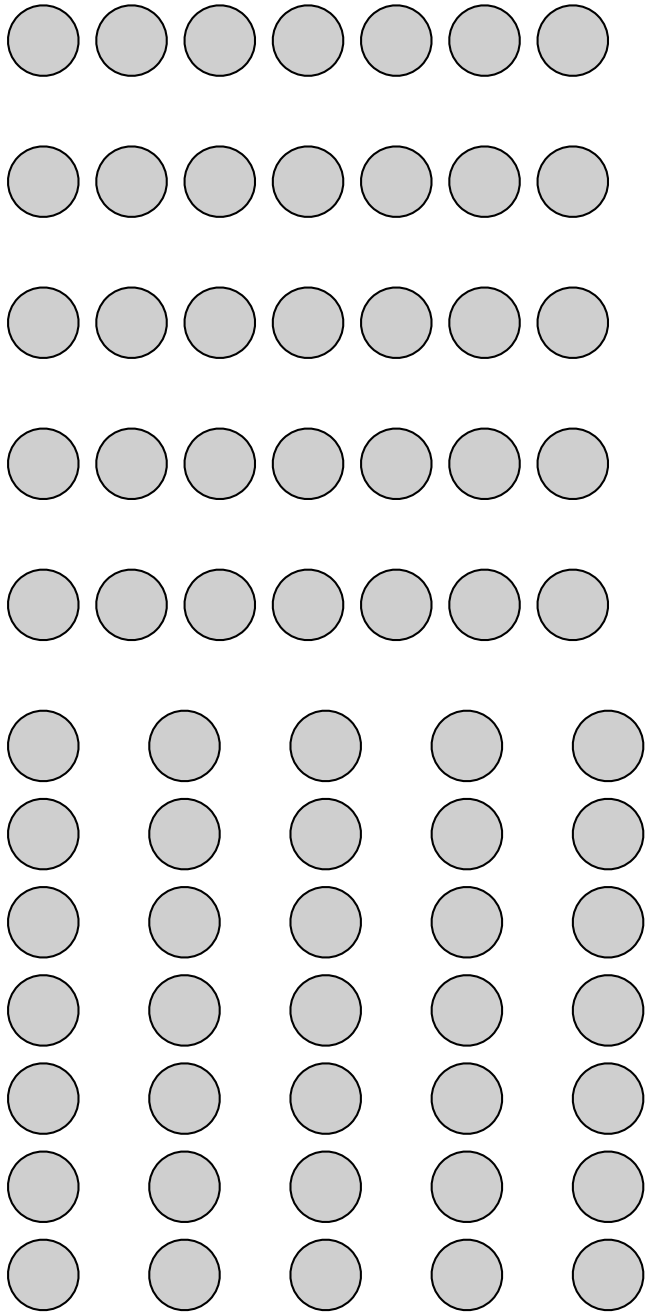
- Gestalt: shape or form
- started in 1890s
  - Kurt Koffka, Max Wertheimer, Wolfgang Köhler
- reaction to *atomism (*nature of things is absolute and not dependent on context)
- *holistic/gestalt*: **the whole is something else than the sum of its parts**

Gestalt principles of perceptual organization

- brain's innate organising tendencies allow us to perceive things as organised wholes than individual elements
- main ideas:
  - we often experience things that are not a part of our simple sensations
  - perception of things is affected by the context
  - ”The whole is something other than the sum of its parts”
  - can be summarized as a set of principles

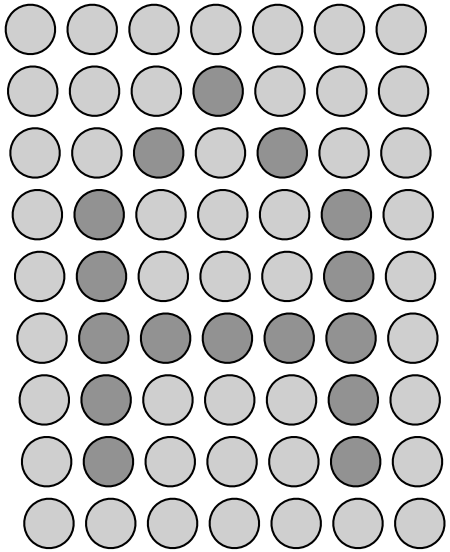
Principle of Proximity

- objects that are close to each other tend to be grouped together



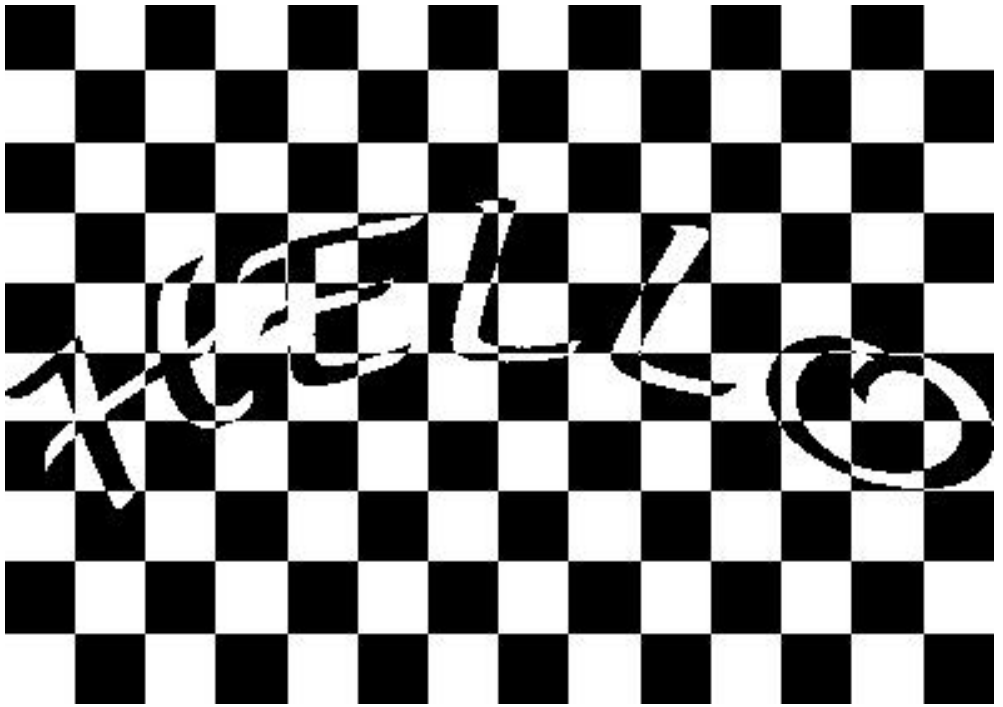
Principle of Similarity

- objects that share visual characteristics such as colour, shape, size, texture, or orientation tend to be grouped together

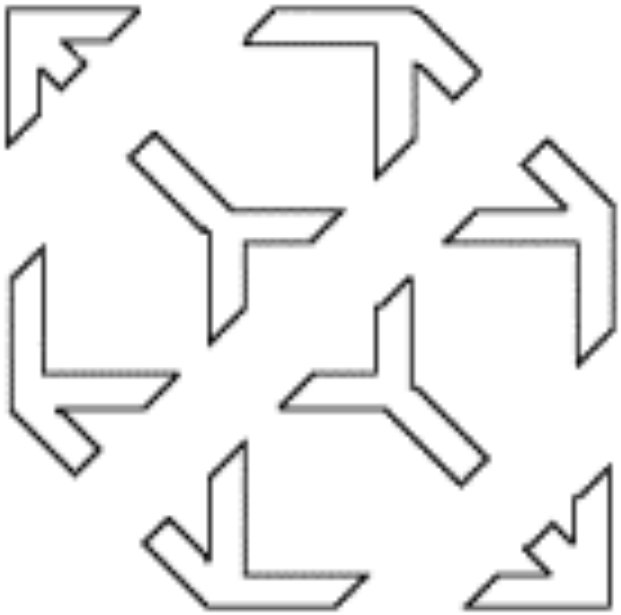


Principle of Continuity

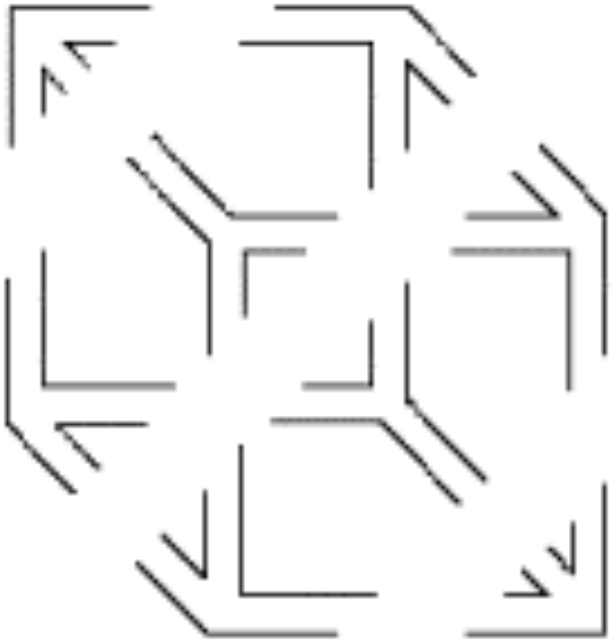
- there is a preference for continuous figures



Principle of Closure



- objects that seem to form closed entities tend to be grouped together

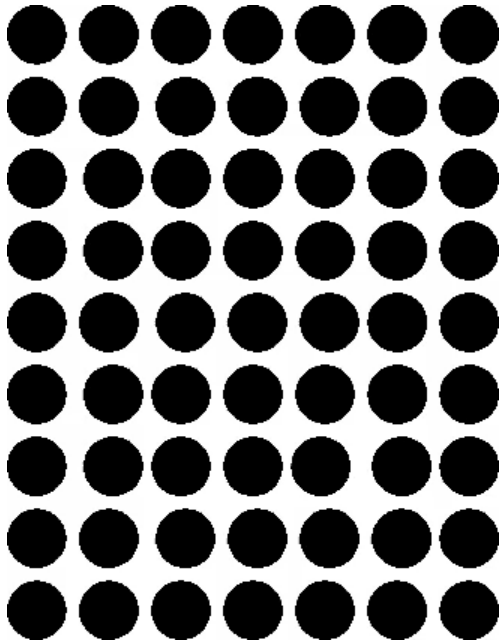


Principle of Closure, Continuity, & Figure-Ground

- the perceptual system fills in the gaps where evidence is incomplete

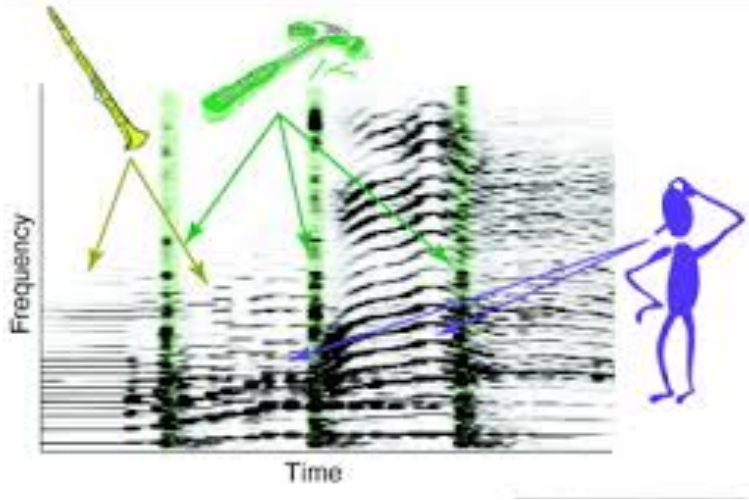
Principle of Common Fate

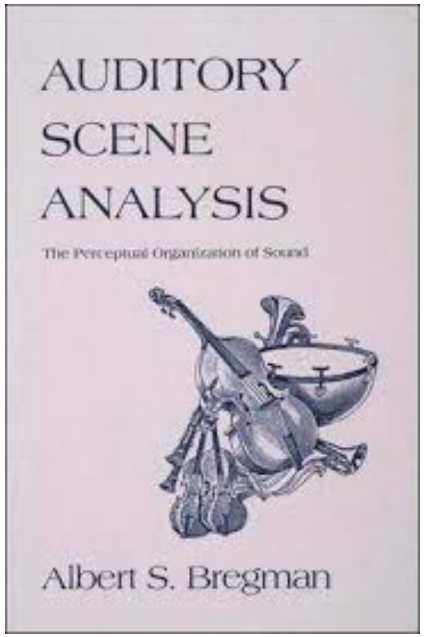
- objects that move together tend to be grouped together



Auditory scene analysis

- three main categories
  - **sequential integration** - putting together events that follow one another in time
  - **spectral integration** - integrating components that occur at the same time in different parts of the spectrum
  - **old-plus-new heuristic** - perceptual continuation of old sound at the presentation of a more complex sound



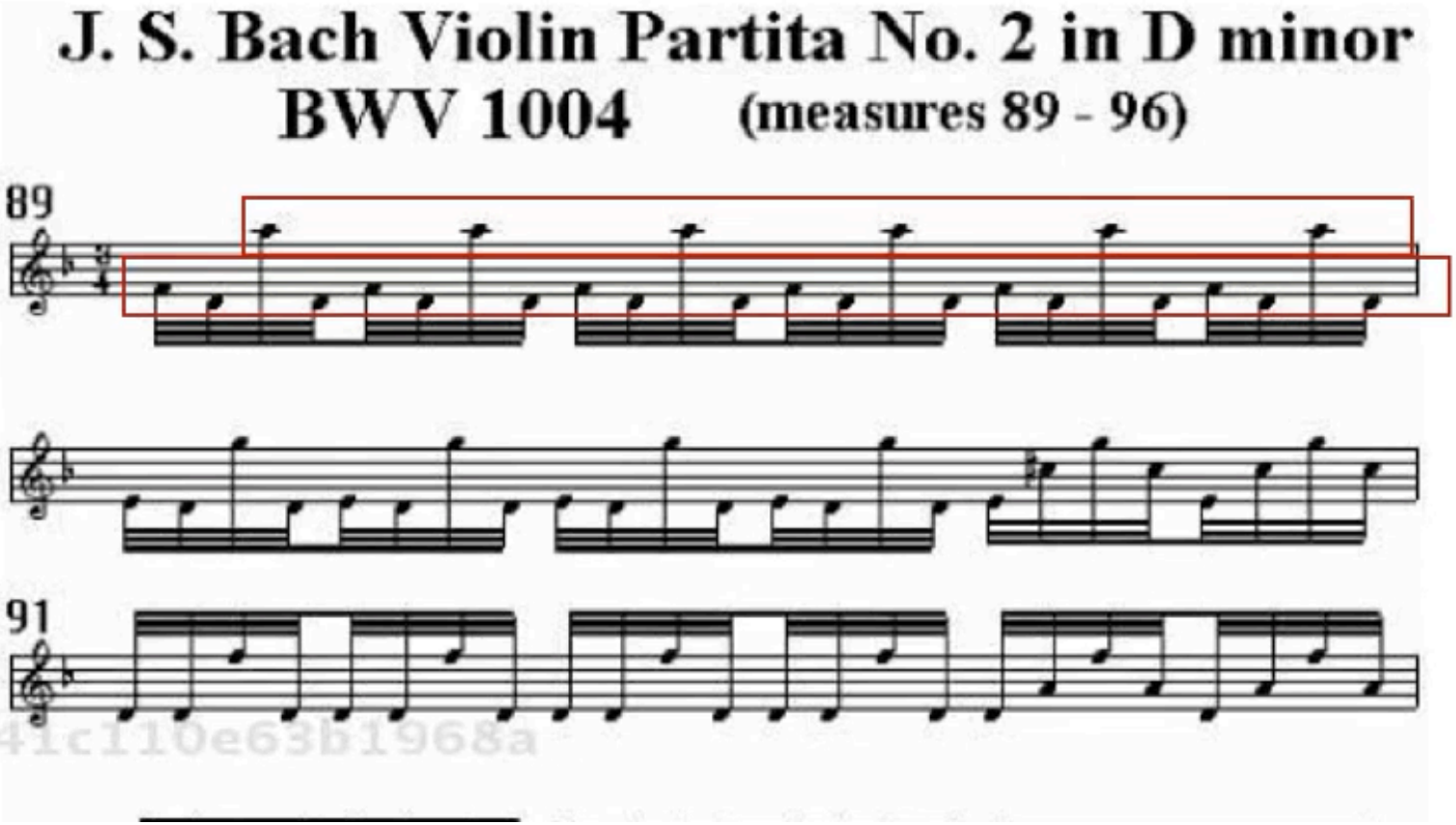


What do you hear?

- On what basis are you segregating them into streams?

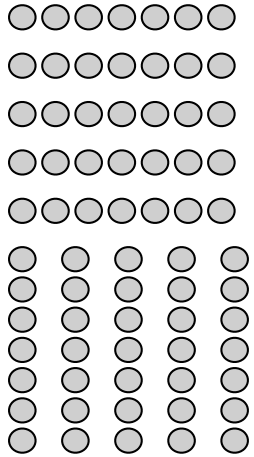
What do you hear?

- Bach: Partita No. 2 BWV 1004



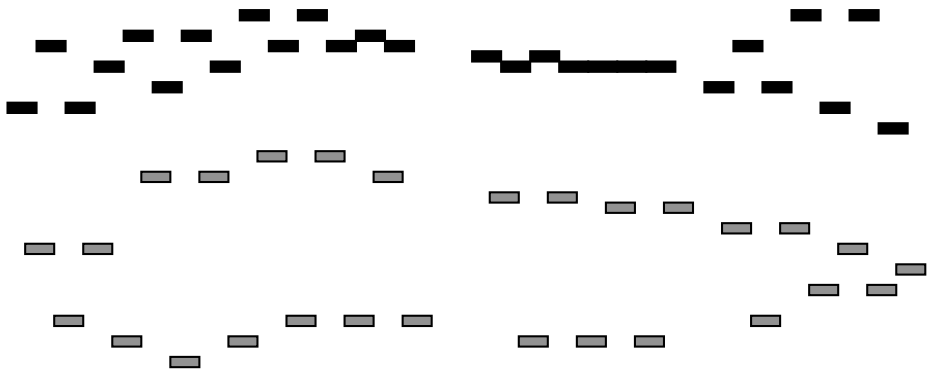
Sequential Integration

Streaming by Proximity



- proximity in auditory domain:
  - proximity in time
  - proximity in pitch
- auditory events that are proximal in pitch and/or time
  - are probably to be created by one and the same source
  - tend to be heard as a stream

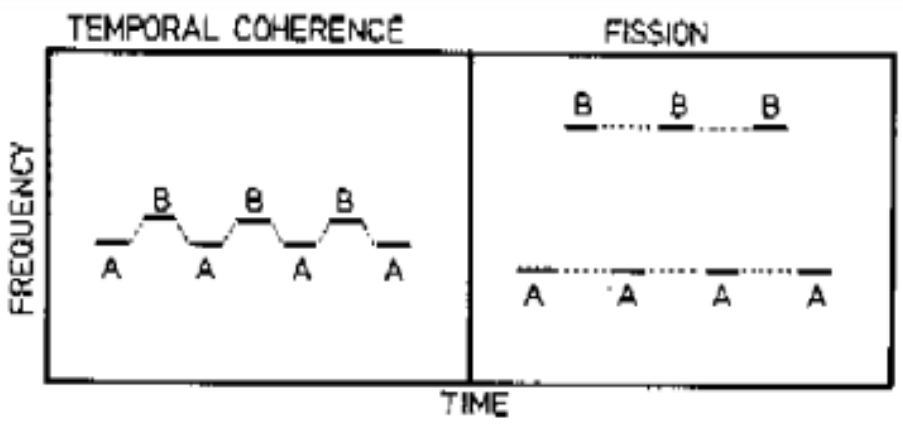
Streaming by Proximity



- interleaved melodies
  - increasing the height difference between melodies results in separation of auditory streams

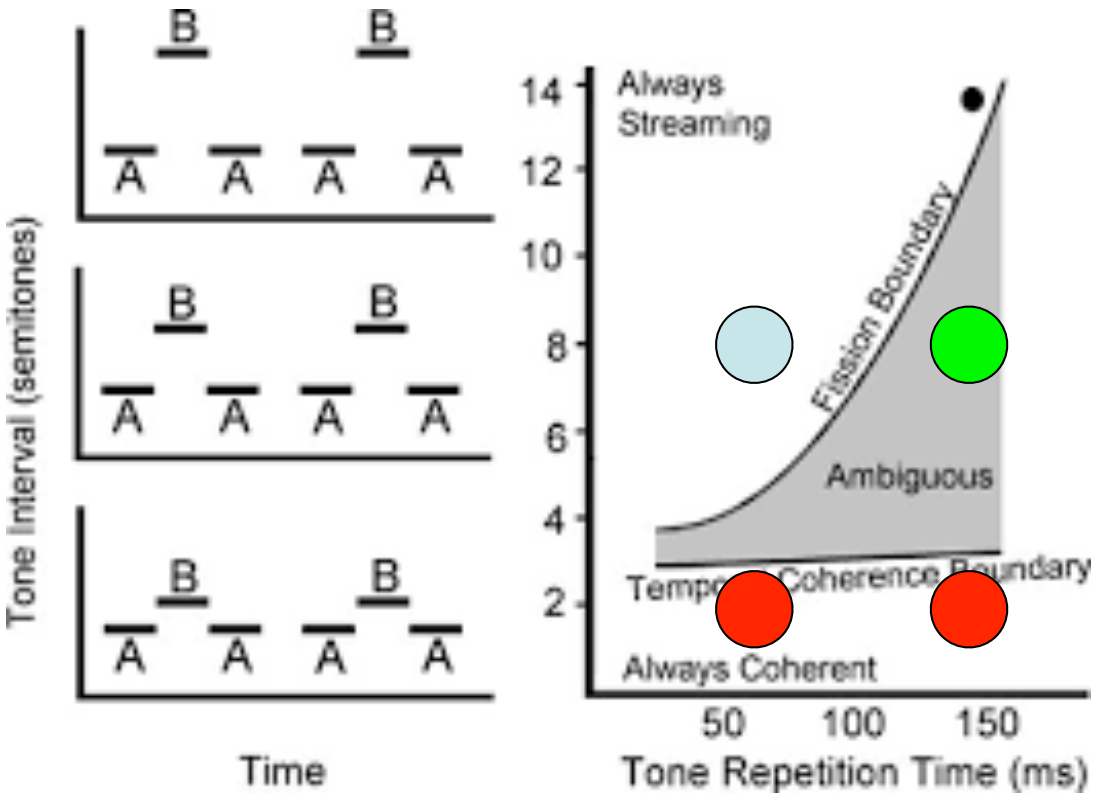
What is proximal enough for streaming to occur?

- van Noorden (1975): dependence of streaming on repetition time and pitch interval
  - Temporal Coherence and Fission
    - occurrence of temporal coherence and fission is determined by the musical interval between the tones

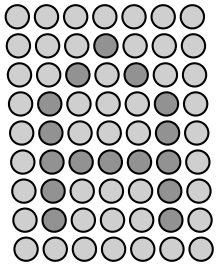


What is proximal enough for streaming to occur?

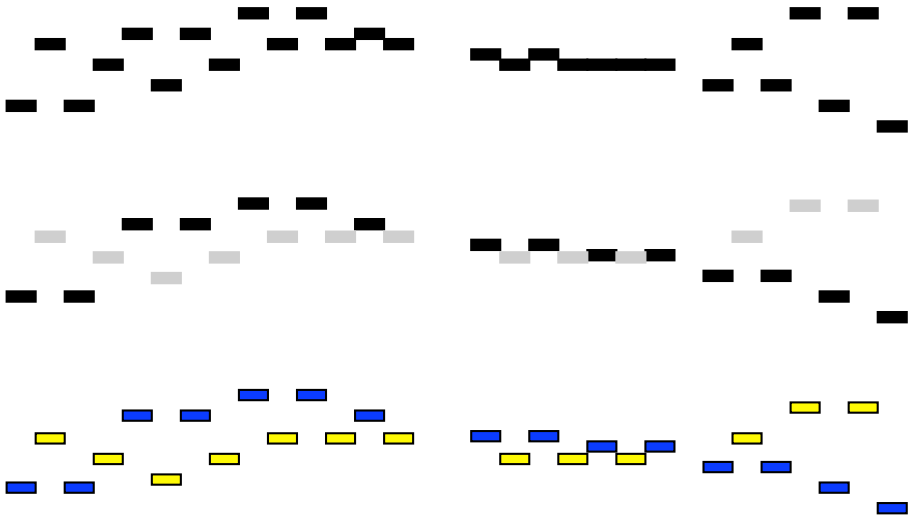
- **A**: 2 streams
- **C**: 1 stream
- **B**: 1-2 streams (depending on attention)



Streaming by similarity



- auditory streaming can be based on
  - similarity in pitch
  - similarity in loudness
  - similarity in timbre



Sequential Integration: Summary

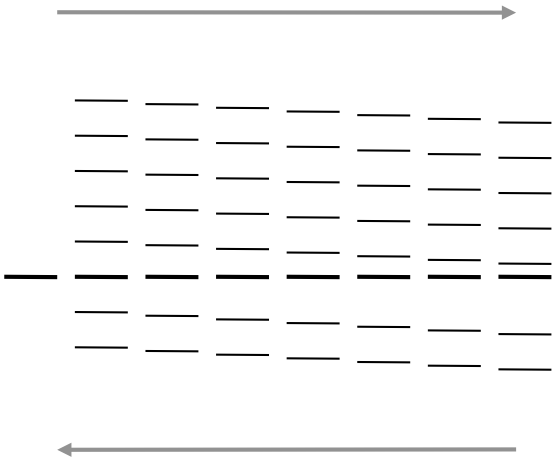
- depends on proximity of
  - time (onset)
  - pitch
- Temporal Coherence and Fission (interval & repetition time)
- depends on the similarity in
  - loudness
  - timbre

Spectral Integration

Spectral Integration

- what kind of principles govern the integration of simultaneous auditory components into perceptual units?

Spectral Relations

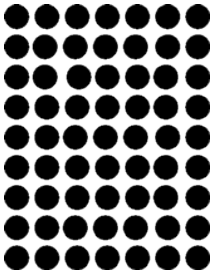


- grouping by harmonicity
  - frequency components sharing the same fundamental are probable to come from the same source and are grouped together

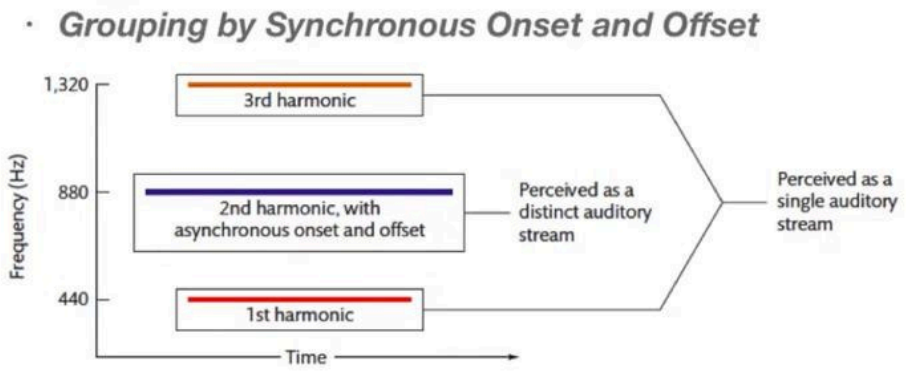
Common Fate

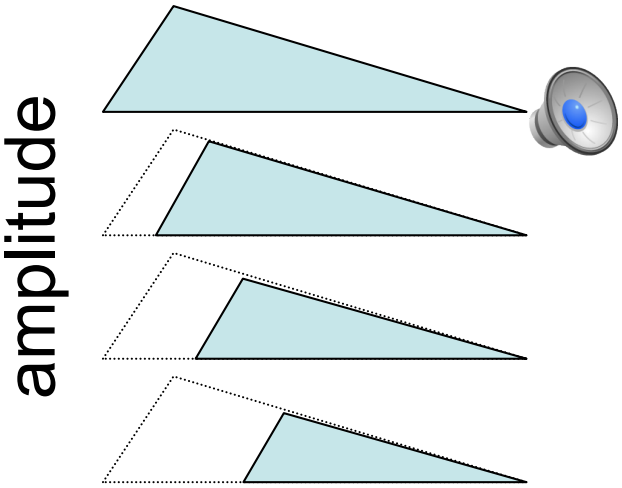
- partials that are in a common harmonic series are more likely to be treated as the spectrum of a single sound.
- when different partials in the spectrum undergo the same change at the same time, they are bound together into a common perceptual unit and segregated from partials whose time-varying behavior is different.
    - this principle applies both to changes in intensity and changes in frequency

Common Fate

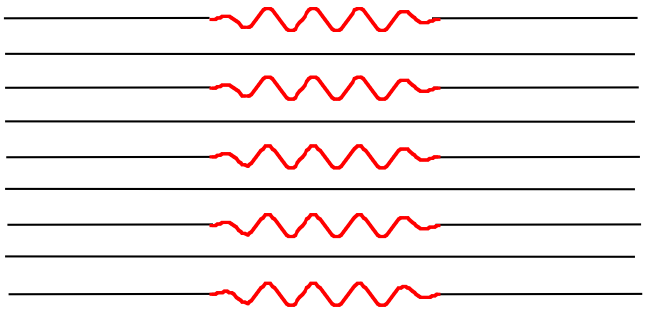


- grouping by onset (and offset)
  - frequency components having proximal onset times are probable to come from the same source and are grouped together



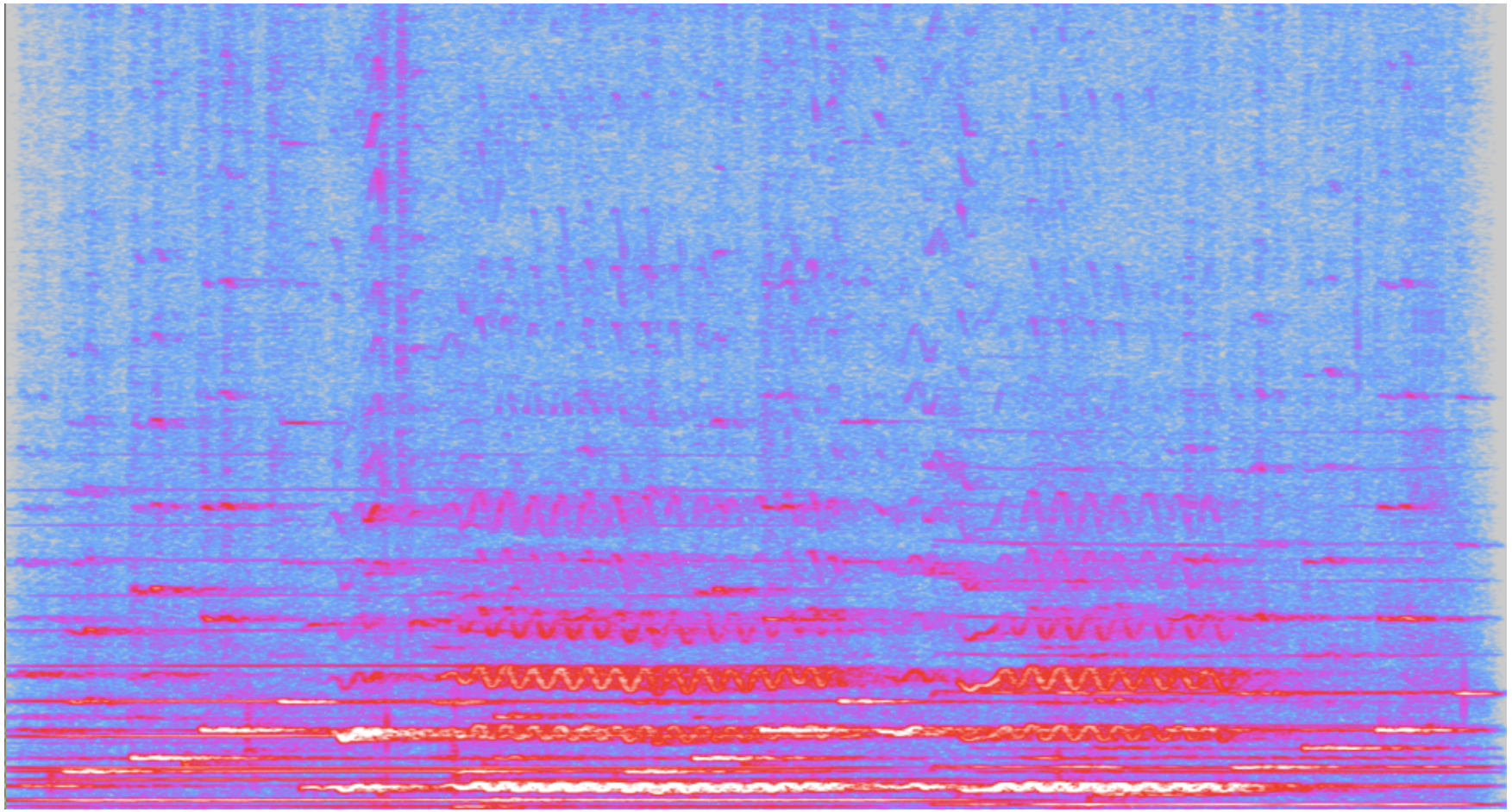


Common Fate: FM



- spectral components sharing the same FM pattern are probably associated to the same source and are grouped together

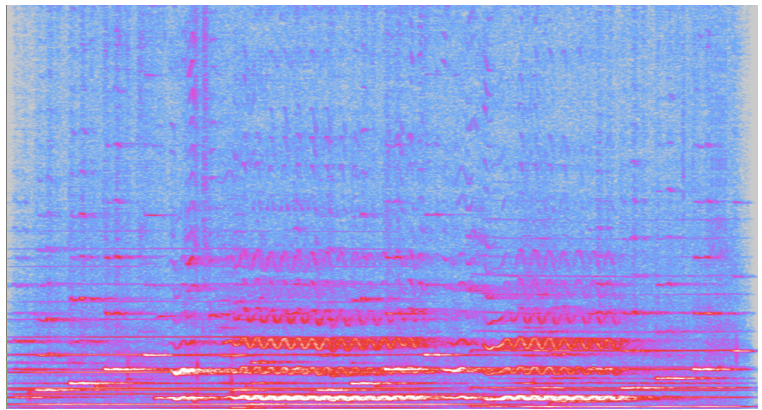
Why does the singer use vibrato?



Why does the singer use vibrato?

- auditory system looks for different sets of harmonic series and segregates them

- to maintain perceptual distinctness is to be producing pitches that are not the same as those produced at the same time by the accompaniment - and hence **stand out**



Old-Plus-New Heuristic

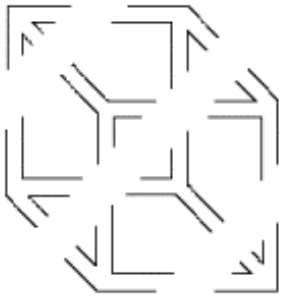
Old-Plus-New Heuristic

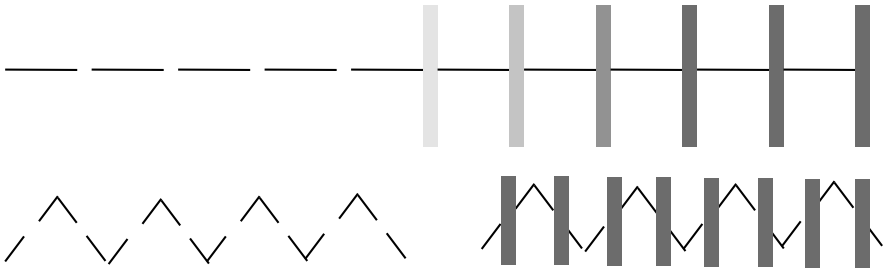
- perceptual continuation of old sound at the presentation of a more complex sound

Old-Plus-New Heuristic

“picket-fence effect”

Apparent continuity through perceptual completion





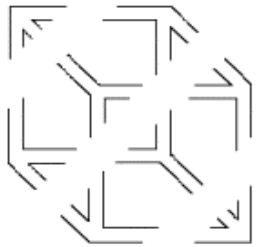
- if a spectrum suddenly becomes more complex or more intense, it is interpreted as the old sound continuing joined by a new one

Summary

- Auditory Scene Analysis
  - formation of auditory streams (perceptual grouping)
  - much of it can be explained by Gestalt principles
- main types of ASA processes
  - sequential integration
  - spectral integration
  - old-plus-new heuristic

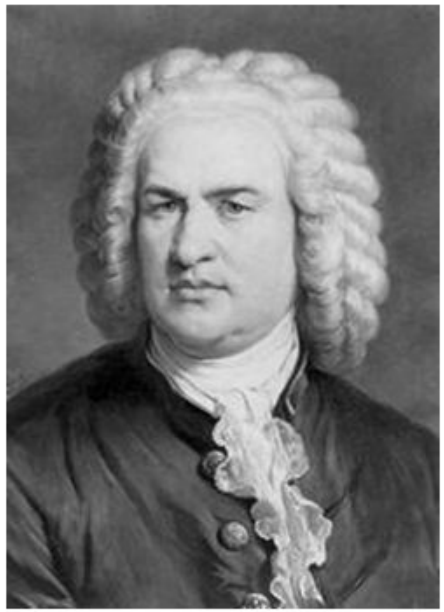
Summary

- sequential integration
  - proximity in time and/or pitch
  - similarity in loudness/timbre
- spectral integration
  - proximal onset & offset times
  - spectral relations (harmonicity)
  - common fate
- old-plus-new heuristic
  - apparent continuity



Gestalt principles of perceptual organization

Bach was the master of auditory stream segregation



proximity

SIMILARITY