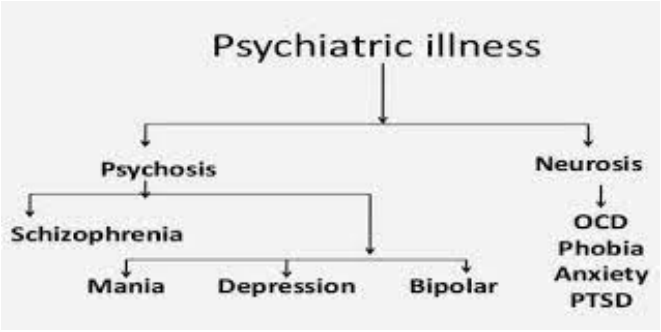
sense ≠ perceive

Auditory hallucinations

"the apparent, often strong, subjective perception of an object or event when no such stimulus or situation is present - perceiving sounds without auditory stimulus"



Auditory hallucinations

- Sensory depravation
  - brain compensation
- Deprivation of social interaction(human conversation)
  - brain more likely to produce hallucinated conversations (eg: sailors)
- Heightened emotional states
  - increase the propensity of the brain to produce corresponding verbal messages (eg: bereavement, abuse, bullying, PTSD)

Auditory hallucinations

- abnormal activation of normal auditory, language perception and production pathways
- activation of PAC, amygdala (emotion), hippocampus (memory), frontal (consolidation) and sensorimotor cortex in schizophrenics (Dirks et al., 1999; Lennox et al., 2000)
- increased blood flow in Broca's area in schizophrenics (McGuire set al., 1993)

"Broca's area is a surprise, since that's where you make sounds, not where you hear them," said Dr. Jerome Engel, a neurologist at the medical school of the University of California at Los Angeles. "I would have expected more brain activity in Wernicke's area, which is where you hear; the usual assumption is that people are listening to thoughts during auditory hallucinations. But this finding suggests that, in terms of unusual brain activity, auditory hallucinations have more to do with the generation of words in the brain than listening to them."

Tinnitus

- “tinnitus” - tinkling in Latin
- noises in the head, not related to any psychiatric condition
- ringing in the left/right ears or in the head (ex: after a loud concert)
- may vary in pitch
  - buzzing
  - hissing
  - humming
  - thumping
  - whistling
  - ticking
  - clicking

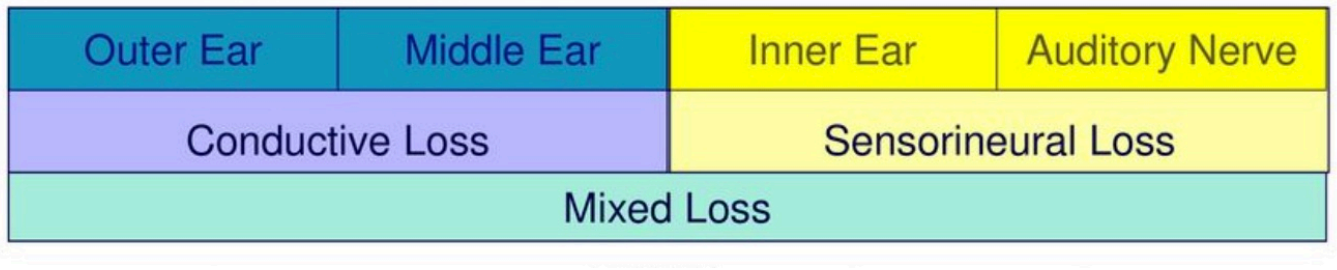
Tinnitus Causes

- damage to the microscopic endings of the hearing nerve in the inner ear due to acoustical trauma
- middle ear infections
- stiffening of the middle ear bones
- foreign object, or earwax touching the eardrum
- high or low blood pressure (blood circulation problems)
- certain types of tumors
- head trauma
- large doses of anti-inflammatories, antibiotics, sedatives, antidepressants, and aspirin
- age

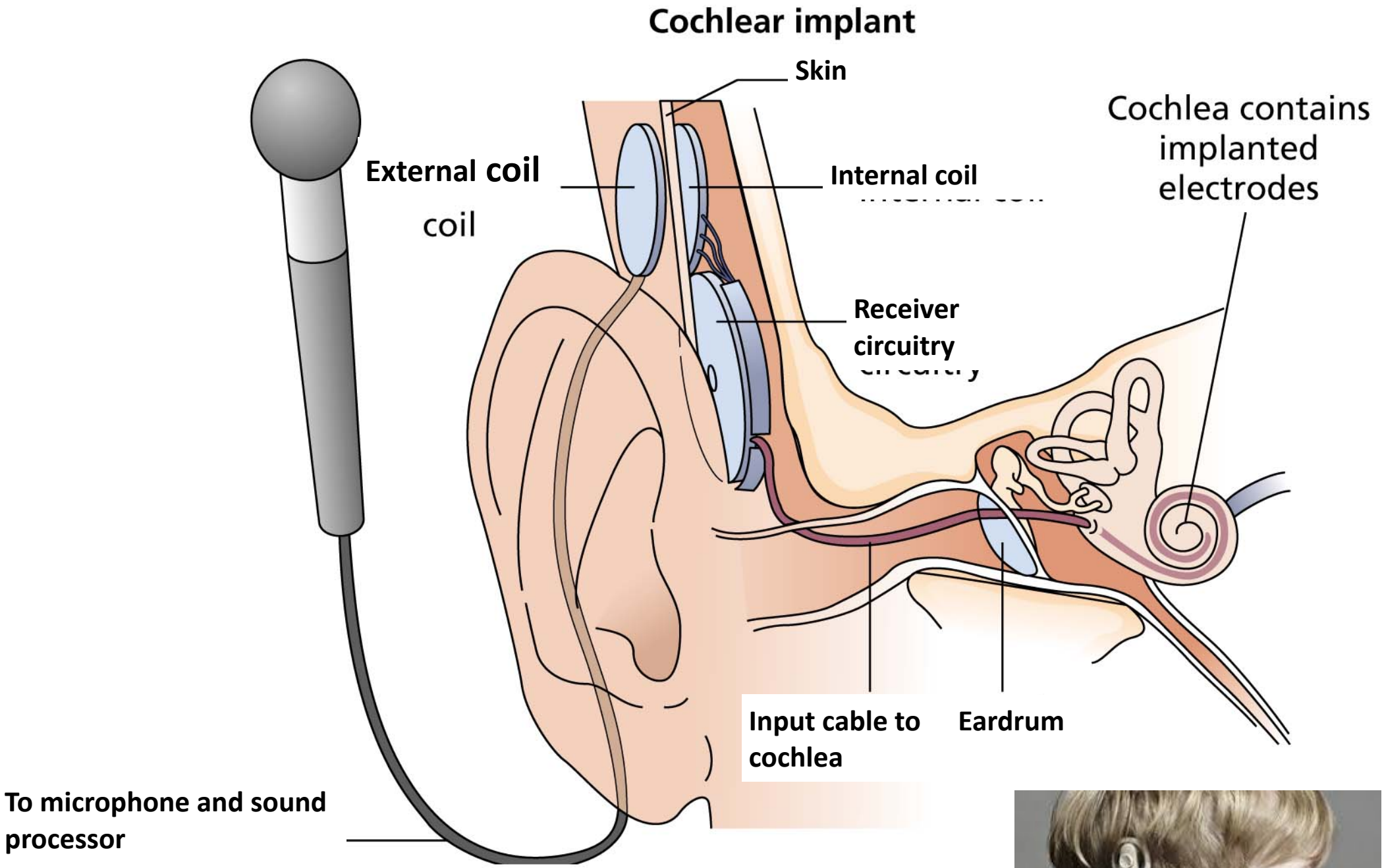
Tinnitus Treatment

- sound therapy
  - broadband noise maskers (white noise) - (auditory masking)
  - living in india helps!!!!!!!!!
- use ear protection in noisy areas

Types of Hearing Loss



- **Conductive Hearing Loss**: Problems in transmitting sound waves to the cochlea
- **Sensorineural Hearing Loss**: Caused by damage to inner ear or auditory nerve
- **Mixed Hearing Loss**



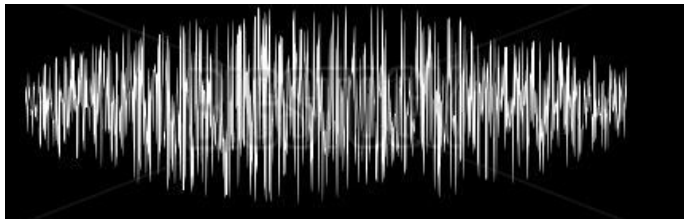
Timbre

Timbre

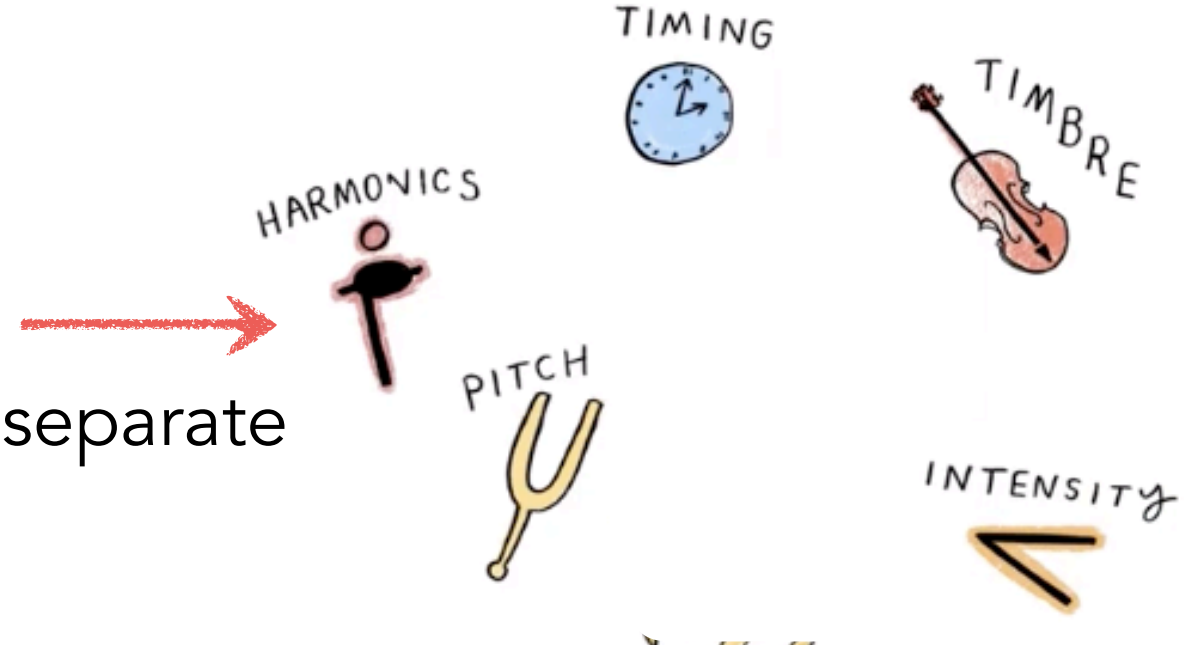
- ”Timbre is the miscellaneous category for describing the psychological attributes of sound, gathering into one bundle whatever was left over after pitch, loudness, and duration had been accounted for.” (Dowling and Harwood 1986)
  - a negative definition or what it is not
- “Psychoacoustician’s wastebasket category”
- timbre is complex - no generally agreed definition
- timbre is multidimensional

Why the fuss about Timbre?

- major structuring force in music and one of the most important and ecologically relevant features of auditory events
  (Menon, Levitin, Smith, Lembke, Krasnow, Glazer et al., 2002, p. 1742)



separate



Cocktail Party Effect

“selective hearing” or “selective attention” - a phenomenon that refers to our ability to focus on one specific auditory stimuli while filtering out others

Why the fuss about Timbre?

- major structuring force in music and one of the most important and ecologically relevant features of auditory events (Menon, Levitin, Smith, Lembke, Krasnow, Glazer et al., 2002, p. 1742)

- vehicle for source identity (McAdams & Giordano, 2009; McAdams, 1993; Handel 1995
  - survival: escaping danger elicits feeling of reward, which can be thought of as a fundamental incentive to human action

Attempts to Define what Timbre is

- ”On analysis, the difference between tone-colors of instruments are found to correspond with **differences in the harmonics** represented in the sound.” (Jacobs 1991. Penguin Dictionary of Music)

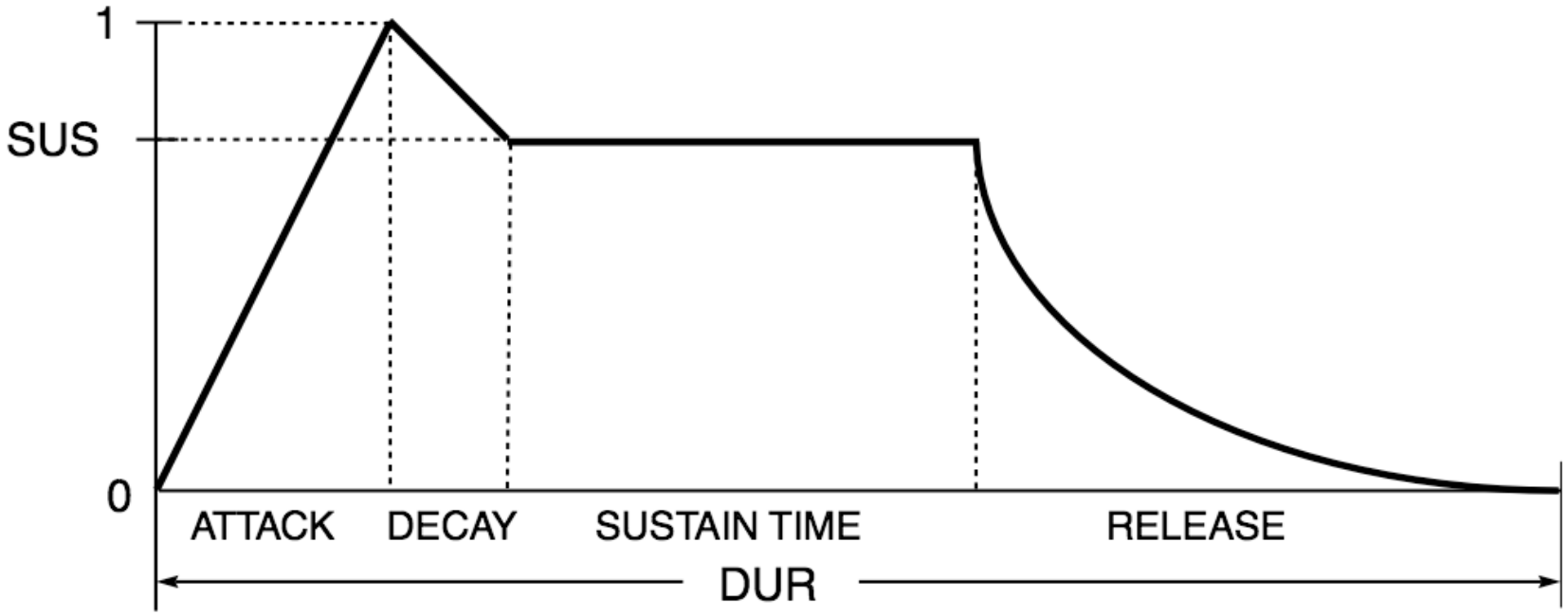
- ”[Sound] quality is determined by the overtones, the distinctive timbre of any instrument being the result of **the number and relative prominence of the overtones** it produces.” (Columbia Encyclopedia)

If timbre depends on ”relative prominence of overtones” only ...

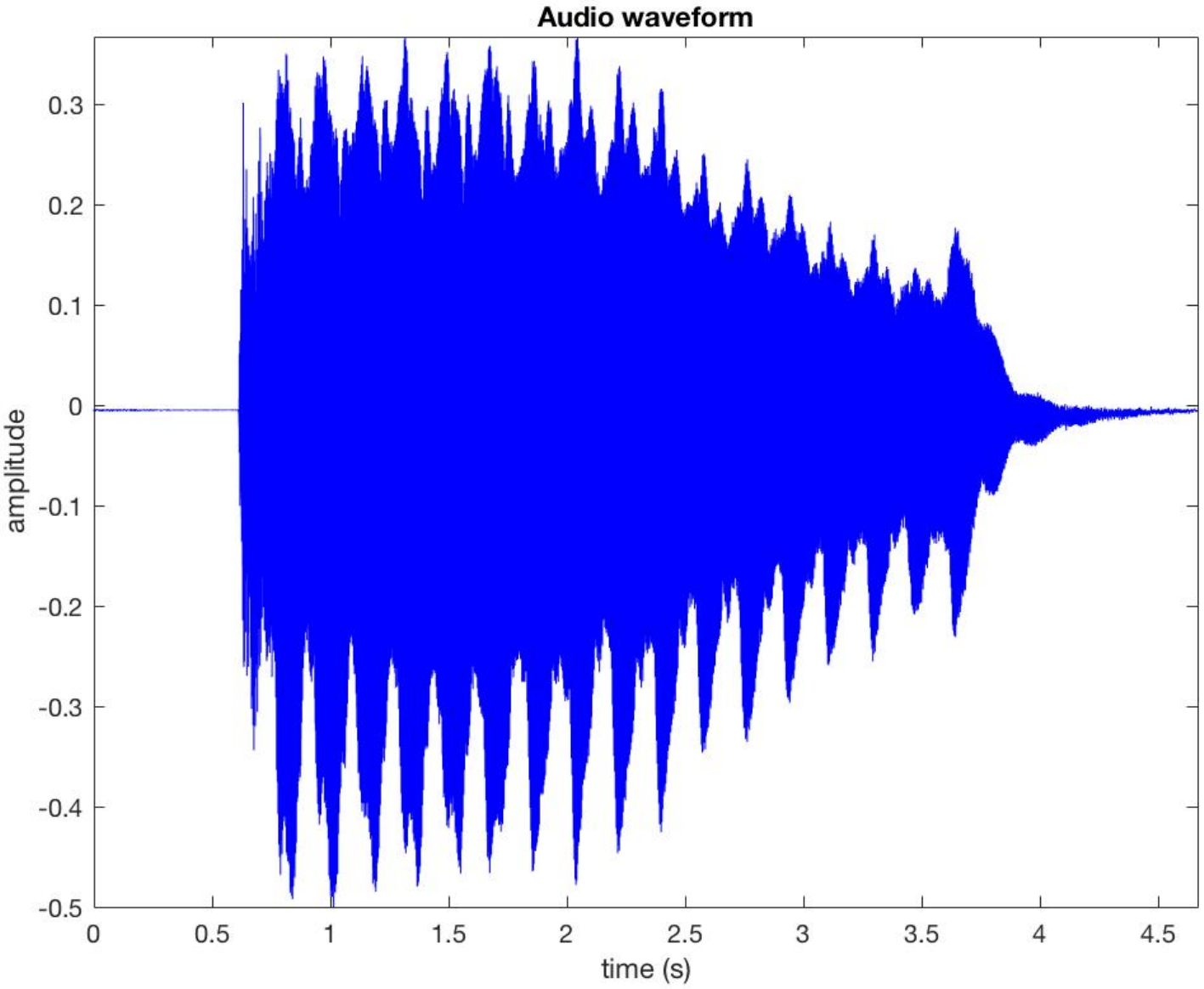
- 1. play some ragtime ...
- 2. play it backwards ...
- 3. reverse the sound file ...
- 1 & 3 have similar overtone structure -> same timbre?

Temporal Envelope

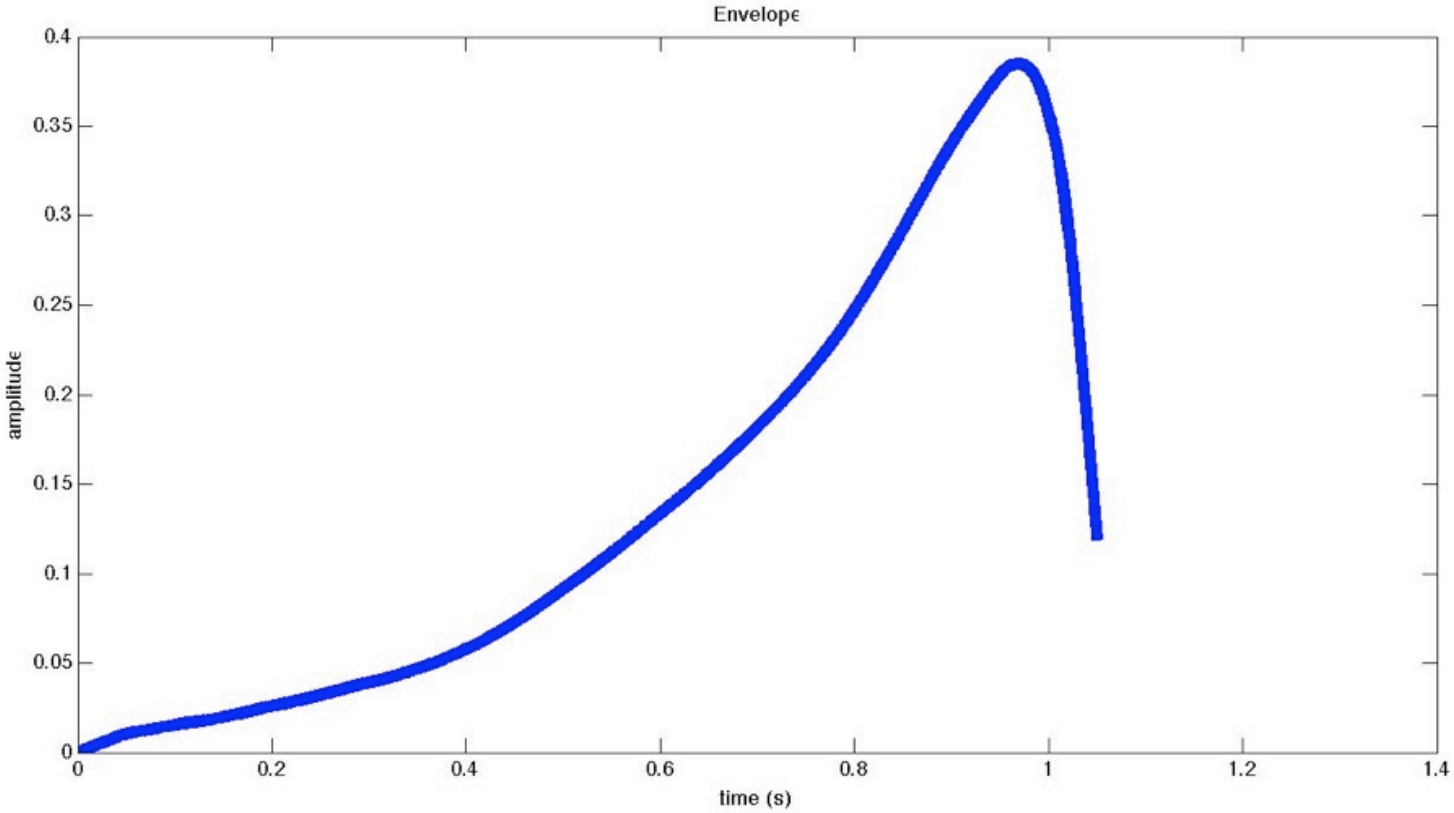
- Attack-Decay-Sustain-Release



Temporal Envelope

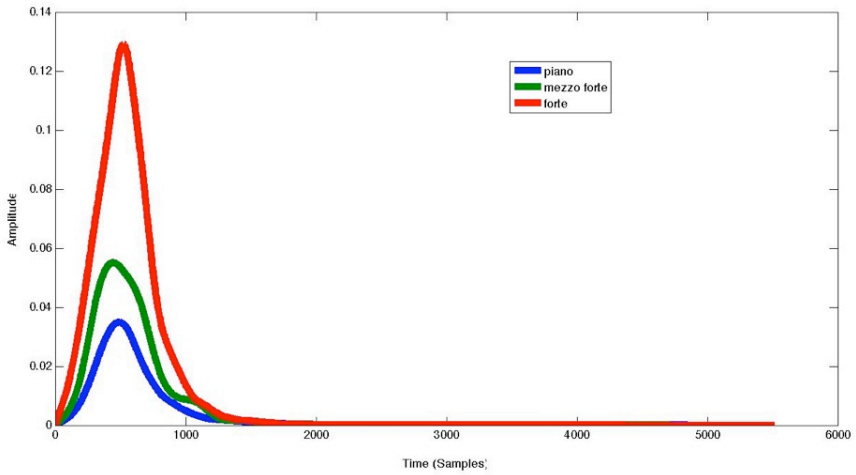


Attack Time & Attack Slope

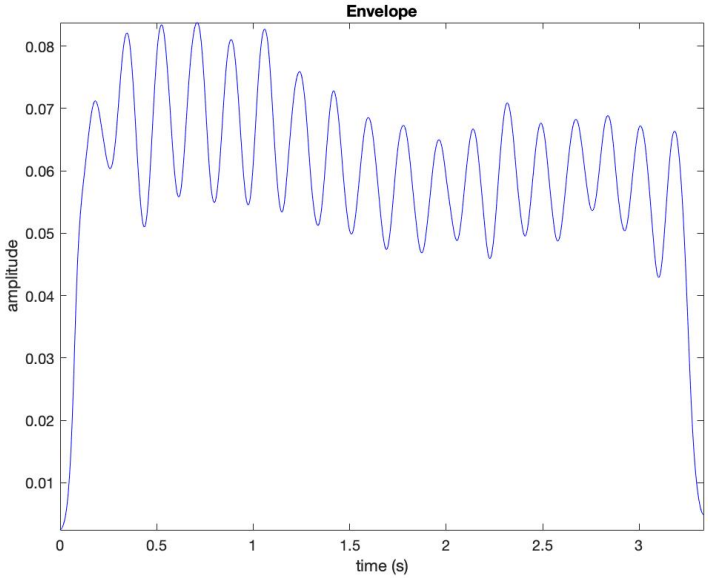


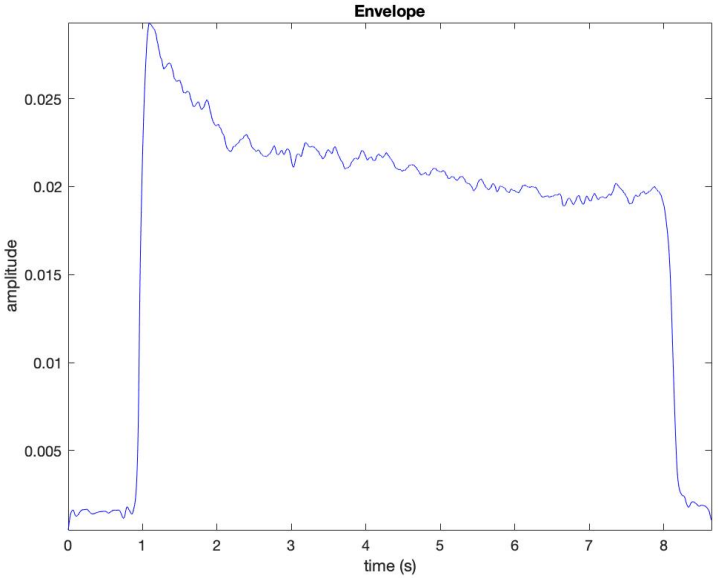
Attack Time & Attack Slope

- removal of attack?
  - difficult to identify the source
- Effect of Loudness
  - affects attack slope



Match the sound to temporal envelope

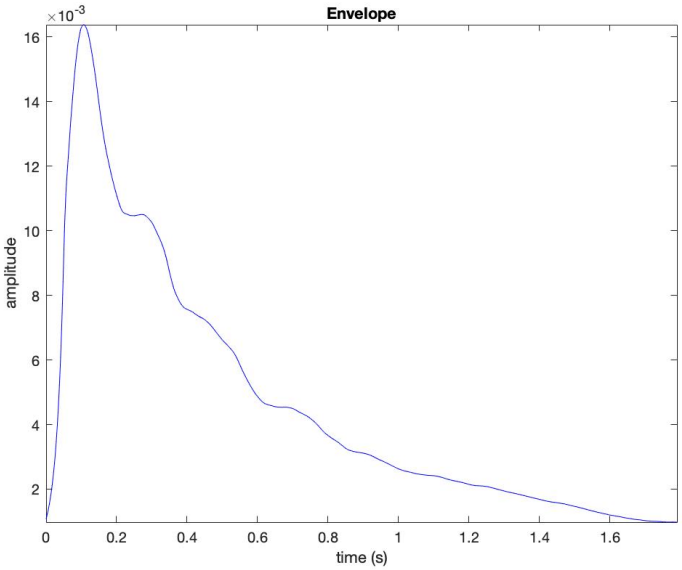




piano

flute

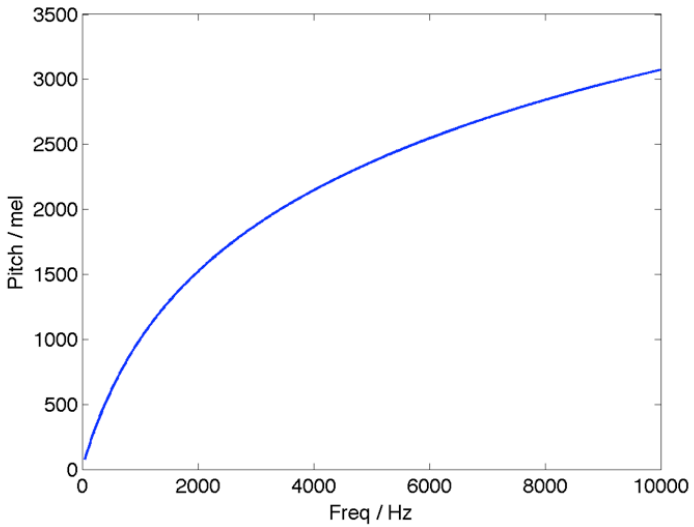
trumpet



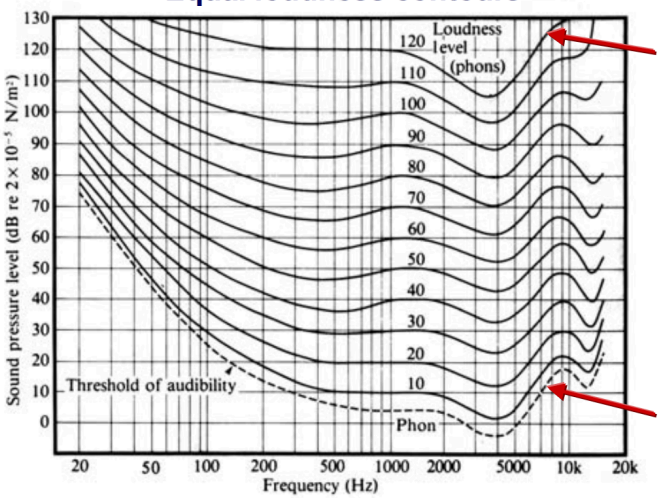
Physical Representations

How would you investigate timbre perception?

Perceptual Representations

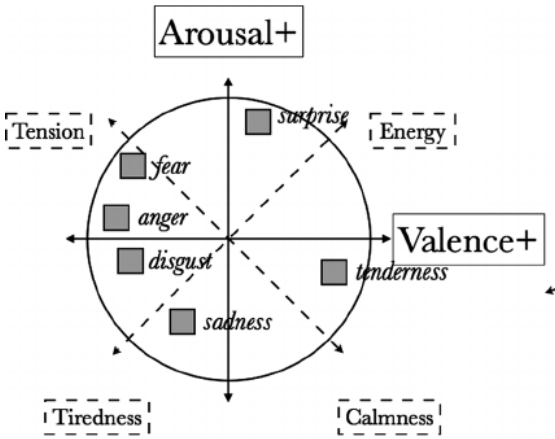


Equal loudness contours

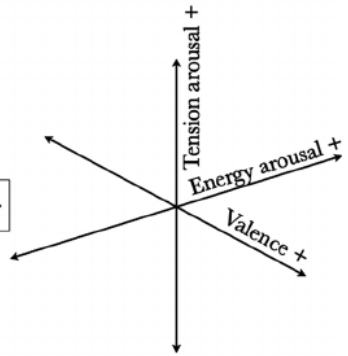


Threshold of pain

Threshold of audibility

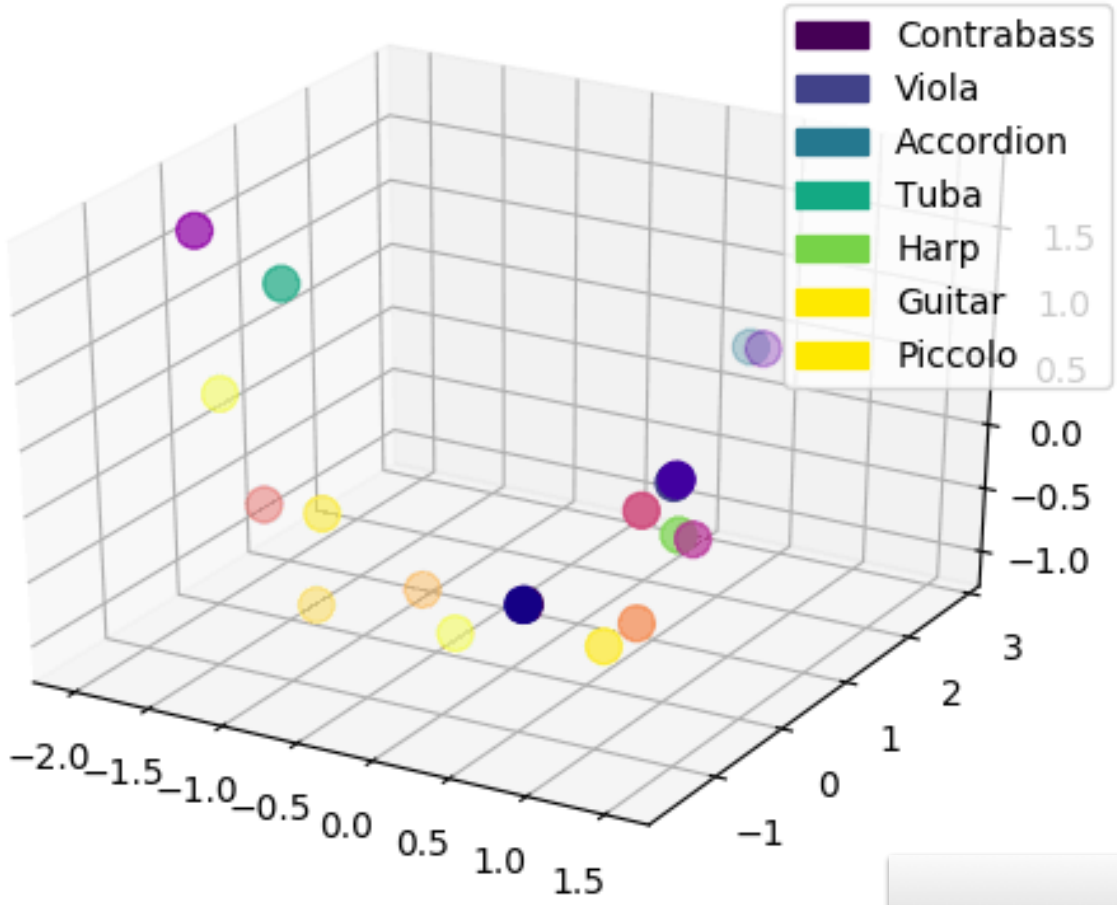


Russell's circumplex model ——
Thayer's model - - -
Basic emotion terms ■



Schimmack & Grob model

Timbre Spaces....



Dimension 3?

Dimension 2?

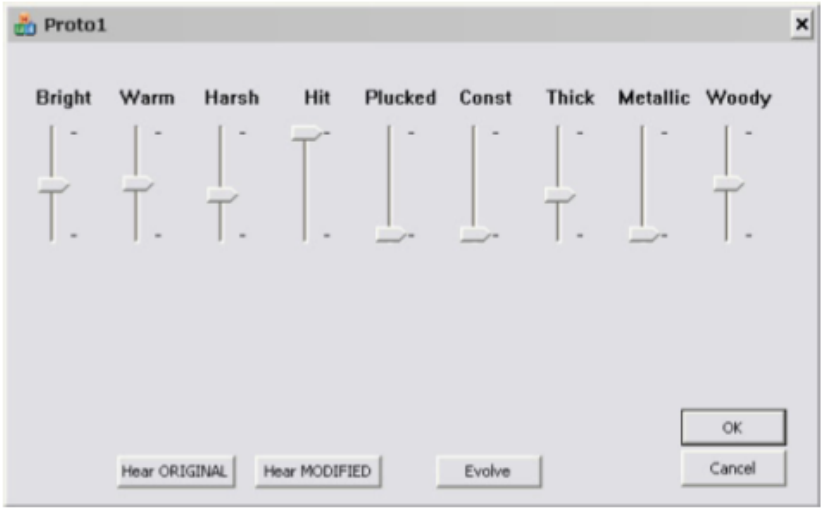
Dimension 1?

Timbre Spaces....

- a model that tries to explain perceptual results such as timbral interval perception
- different sets of stimuli give rise to different sets of dimensions with differing acoustic correlates
- hence requires a meta-analytic approach

Perceptual Descriptions?

- why is it important?
  - "common language" between artist and producer



Gounaropoulos & Johnson, 2006

Timbre
Semantic Studies

- Adjectives describing timbre
- Surveys, Semantic Differential, VAME
  – *harsh, bright, full, warm .....*
- Acoustic correlates of descriptors
  – *spectral centroid, spectral slope, roughness,....*

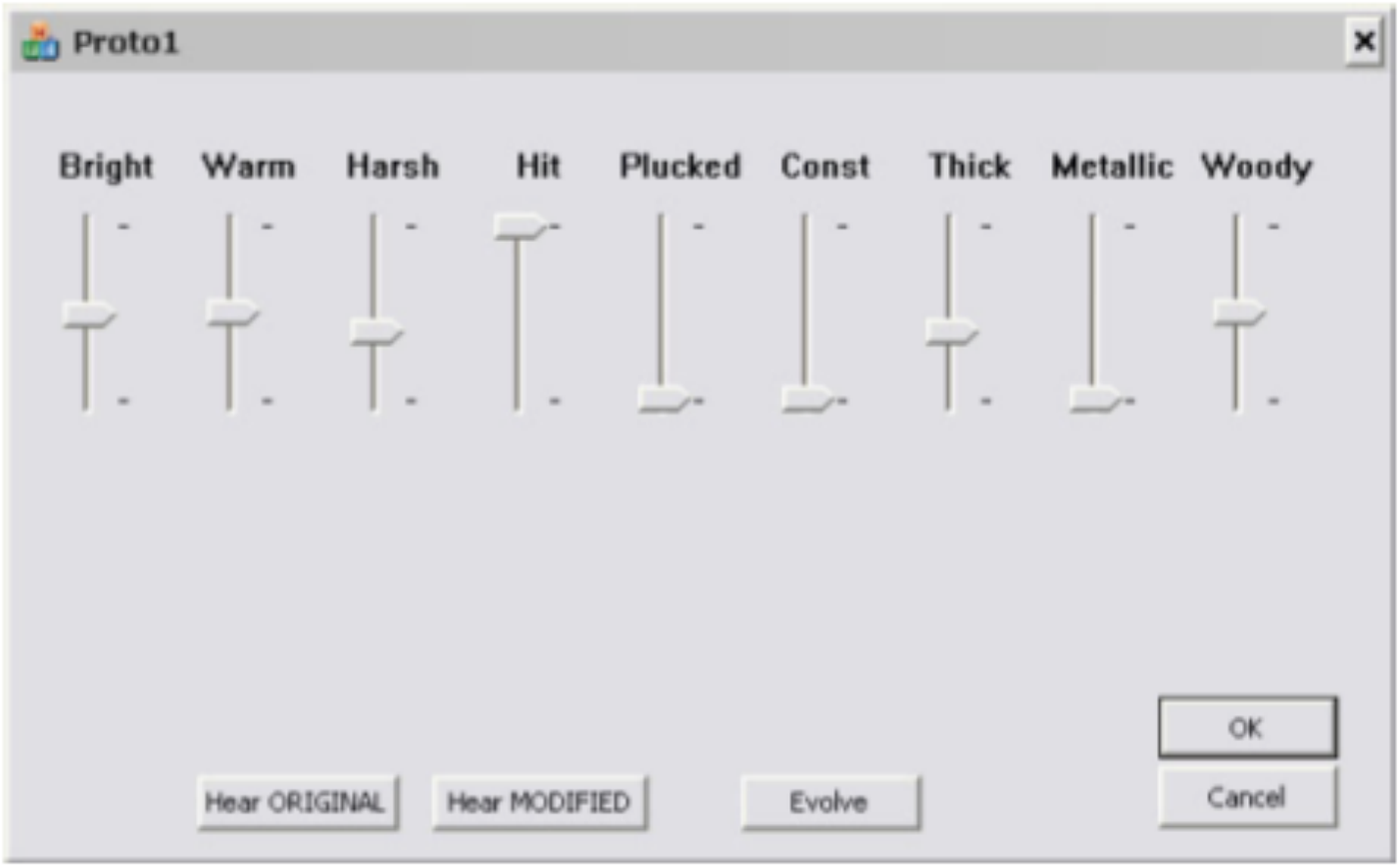
Perceptual Descriptions

- proposed rating scales (W. Sethares 1999) :
  - dull <-> sharp
  - cold <-> warm
  - soft <-> hard
  - pure <-> rich
  - compact <-> scattered
  - full <-> empty
  - static <-> dynamic
  - colorful <-> colorless

Physical and Perceptual Correlates of Timbre (Bolger 2005)

Name	Type	Physical Correlate	Perceptual Correlate	Description
Spectral centroid	Spectral	Energy concentration in low/high spectral area	Brightness/ Dullness	Balance of energy in spectrum.
Irregularity	Spectral	Fluctuating energy between adjacent partials	Richness	Amplitude variation of adjacent components.
Roughness	Spectral	Beating of overlapping partials	Harshness/ Smoothness	Inharmonic and noise components in spectrum.
Harmonicity	Spectral	Harmonic/ Inharmonic	Cohesive/ Diffuse	Ratio of harmonic to inharmonic spectral components.
Attack/ Decay times	Temporal	Slope of attack and decay	Instrument identification	Time taken to reach max. amp from 0 (attack).

Timbre Synthesis Interfaces



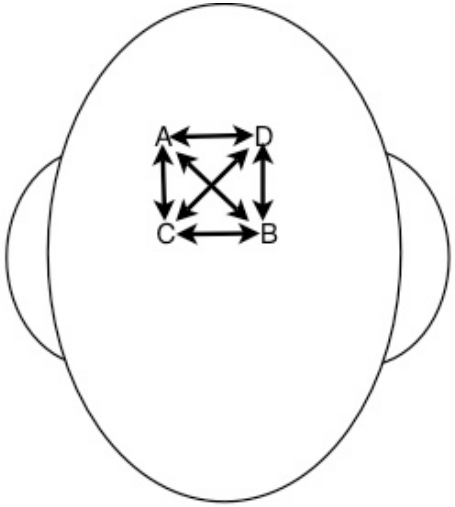
- Gounaropoulos & Johnson, 2006

Perceptual and Acoustical Correlates of Timbre

- A few studies have aimed at creating ‘physical’ timbre spaces from features of the audio in order to find correlations with perceptual timbre spaces (De Poli et al. (1993), Cosi et al. (1994), Toiviainen et al. (1995), Loureiro et al. (2004), Teresawa et al.(2005))
- clustering of sounds in these studies has been found to be comparable to human similarity judgments

Timbre Spaces....

A
B
C
D

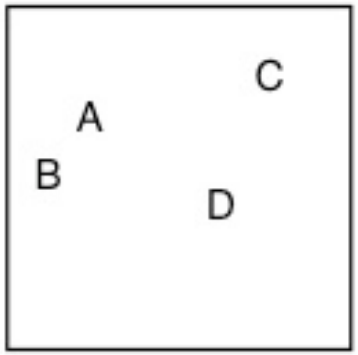


	A	B	C	D
A		2	5	6
B	2		3	4
C	5	3		2
D	6	4	2	

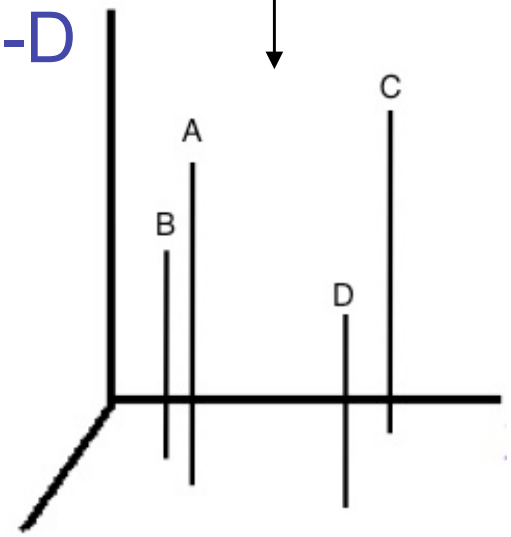
MDS

1-D

2-D



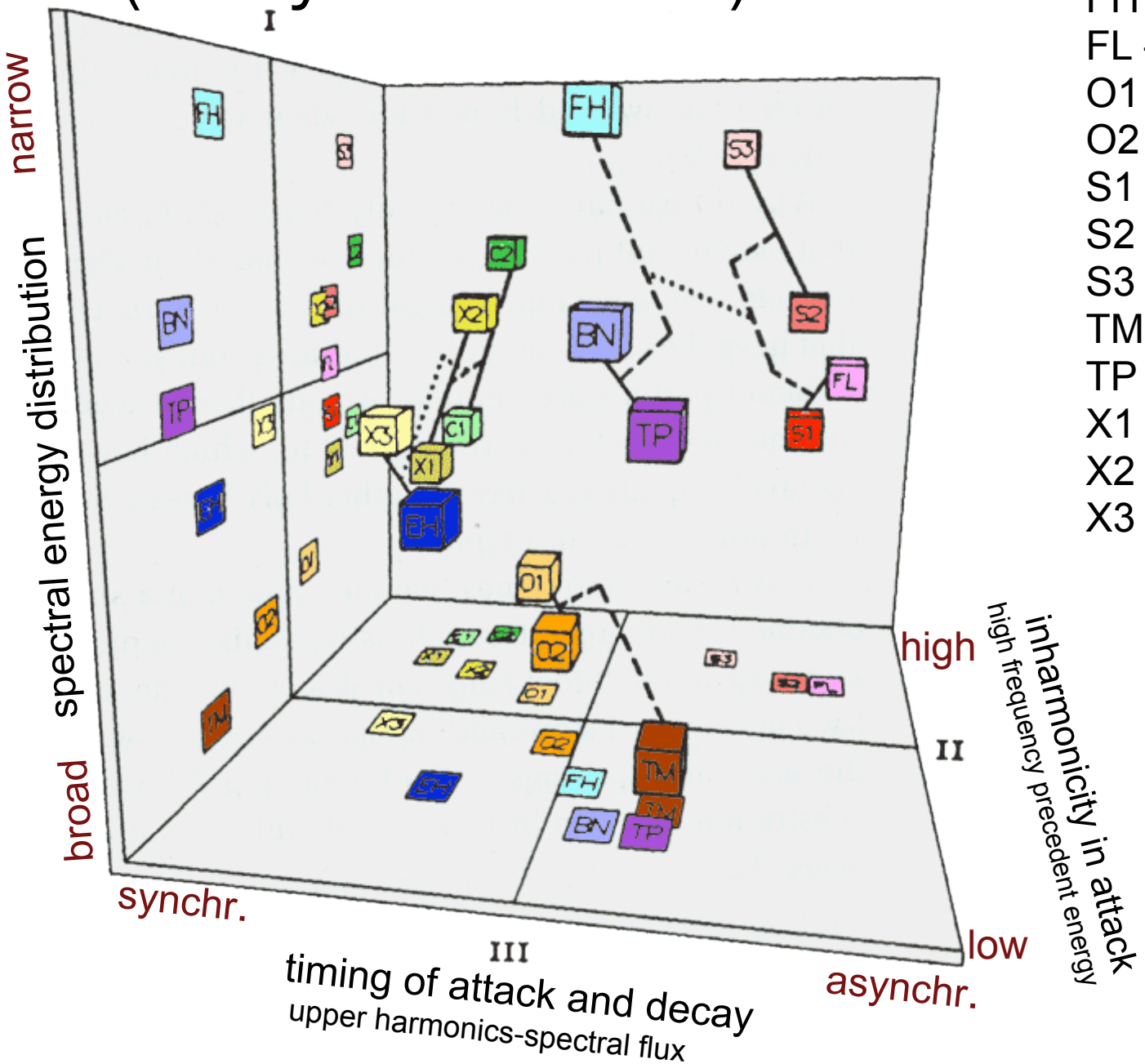
3-D



Correlating Timbre with Physical Attributes of Tones

- Grey & Moorer 1977:
  - 16 synthetic tones
    - equal pitch and duration
    - resembled acoustical instruments
  - similarity rating experiment
    - perceived similarity of all pairs of tones
  - Multidimensional Scaling solution
    - projection of timbres onto a 3-D space

Timbre Space (Grey & Moorer)



BN - Bassoon
C1 - E flat Clarinet
C2 - B flat Bass Clarinet
EH - English Horn
FH - French Horn
FL - Flute
O1 - Oboe
O2 - Oboe
S1 - Cello, muted sul ponticello
S2 - Cello
S3 - Cello, muted sul tasto
TM - Muted Trombone
TP - B flat Trumpet
X1 - Saxophone, played mf
X2 - Saxophone, played p
X3 - Soprano Saxophone

Meta-analysis of Timbre Spaces

- Recorded musical instrument tones
  - Lakatos(2000-winds strings,percussion,combined), Iverson & Krumhansl (1993 - whole tones)
- Recorded and modified instrument tones
  - Grey(1977), Grey&Gordon(1978), Iverson & Krumhansl (1993 - attack and remainder portions of tones)
- FM-synthesized simulations of orchestral instrument tone
  - Krumhansl(1989), McAdams et al.(1995)

Meta-analysis of Timbre Spaces

- Use same MDS technique on all data sets
- Use same set of acoustical descriptors derived from signals on all sound sets
- The meta-analytic approach seeks generalization of results across diverse experimental conditions

Interpretation of Dimensions

- Across studies, several different potential acoustic cues correspond to timbre dimensions
  - **Spectral centroid**
  - Spectral deviation
  - Spectral density
  - **Attack time**
  - Decay time
  - Amplitude envelope
  - **Spectral flux**
  - Pitch strength
  - Attack synchrony
  - Attack centroid
  - Noisiness

spectral
temporal
spectrotemporal