Psychoacoustics

6th lesson

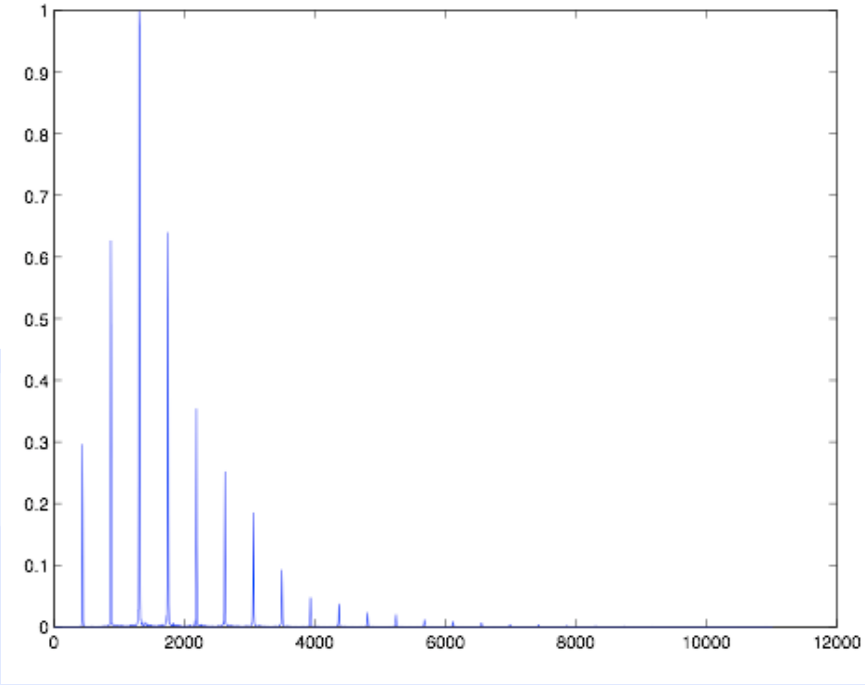
Timbre

Definition

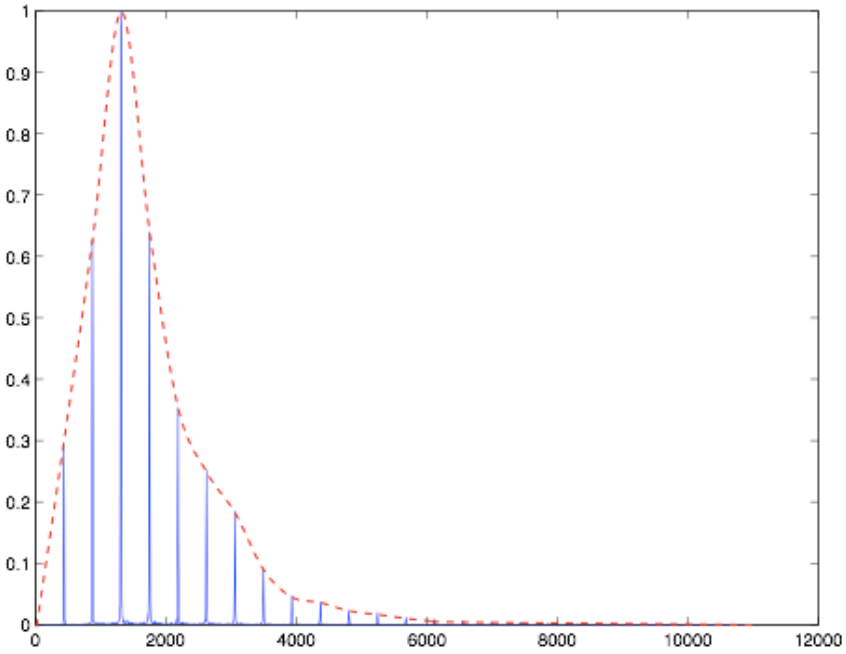
- Difficult to define
- Allows distinction of instruments
- Characteristics like light, dark, hollow, pointed, rich, thin
- These qualities are related spectral phenomena

Spectra

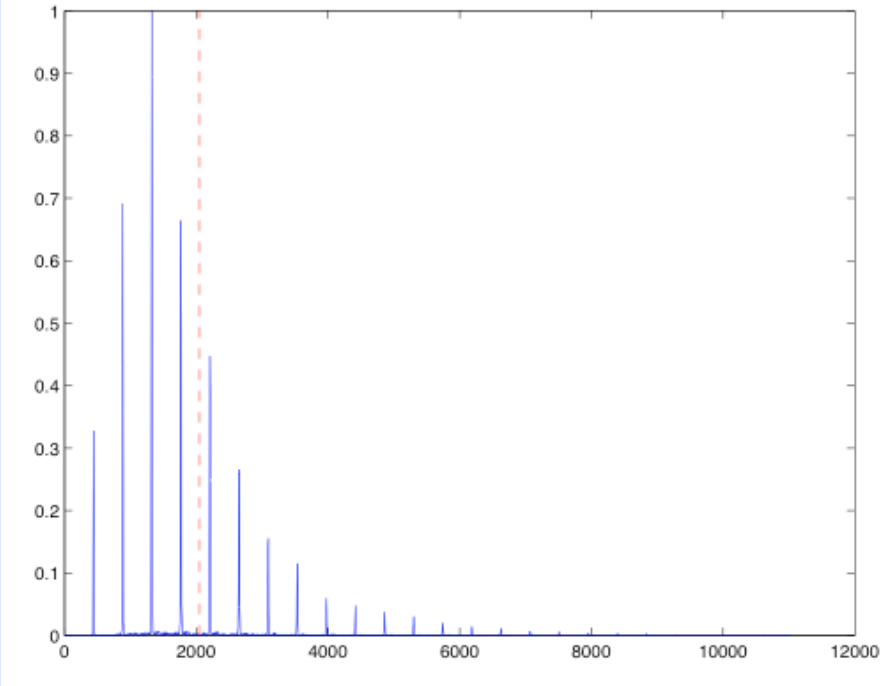
- Global properties
  - Spectral envelope
  - Centroid
  - Formants



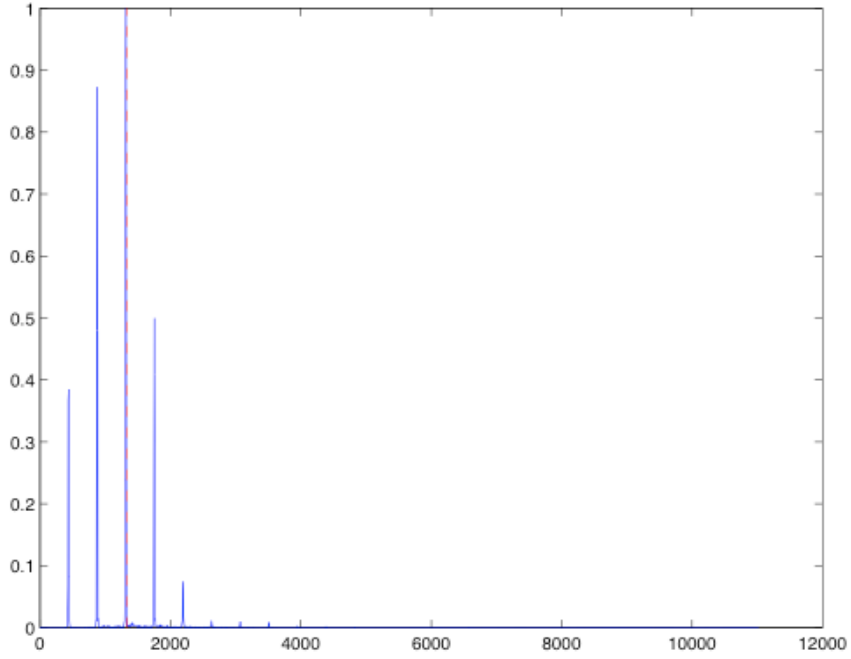
Spectrum



Envelope



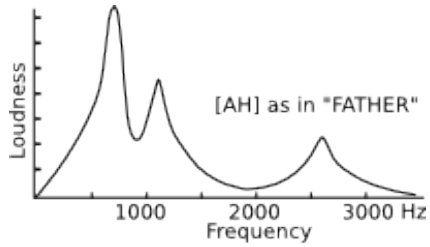
Centroid of a loud trumpet tone

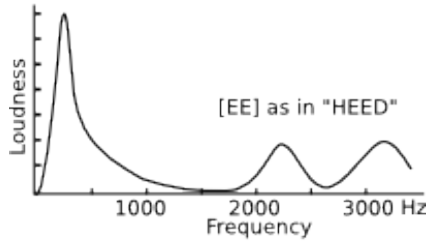


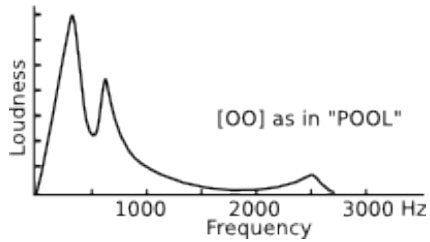
Centroid of a soft trumpet tone

Formans

-	Formant	heed	head	had	hod	haw'd	who'd
Male	F1	270	530	660	730	570	300
-	F2	2290	1840	1720	1090	840	870
-	F3	3010	2480	2410	2440	2410	2240
Female	F1	310	610	860	850	590	370
-	F2	2790	2330	2050	1220	920	950
-	F3	3310	2990	2850	2810	2710	2670
Child	F1	370	690	1010	1030	680	430
-	F2	3200	2610	2320	1370	1060	1170
-	F3	3730	3570	3320	3170	3180	3260







Formants in case of vowels

- Source-filter model
  - Sound source (excitation): Vocal cords
  - Filter (speech production): mouth, tongue, lips
- Vibrato makes synthetic voices appear human.

Sound example: a, e, u:

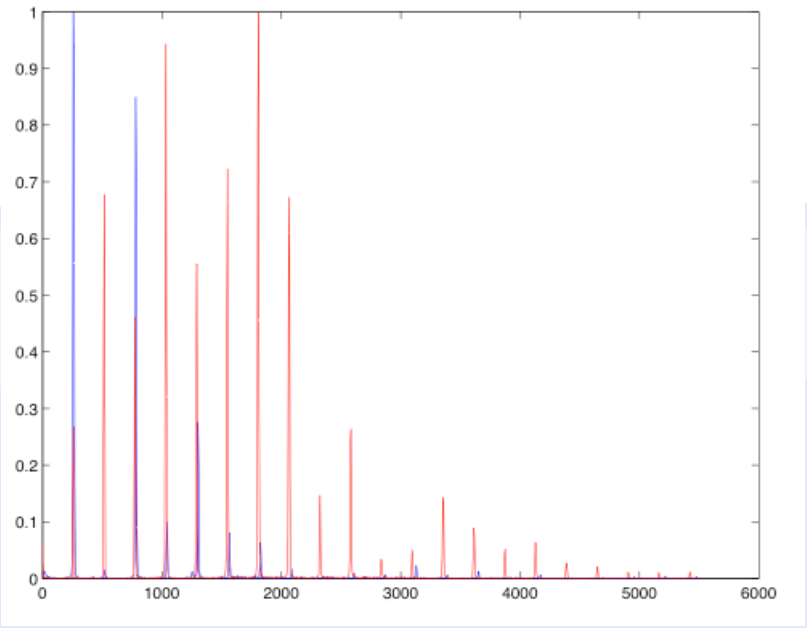
Farinelli

- http://mediatheque.ircam.fr/sites/voix/creer/farinellimov.html
- http://www.imdb.com/video/screenplay/vi3986882841/

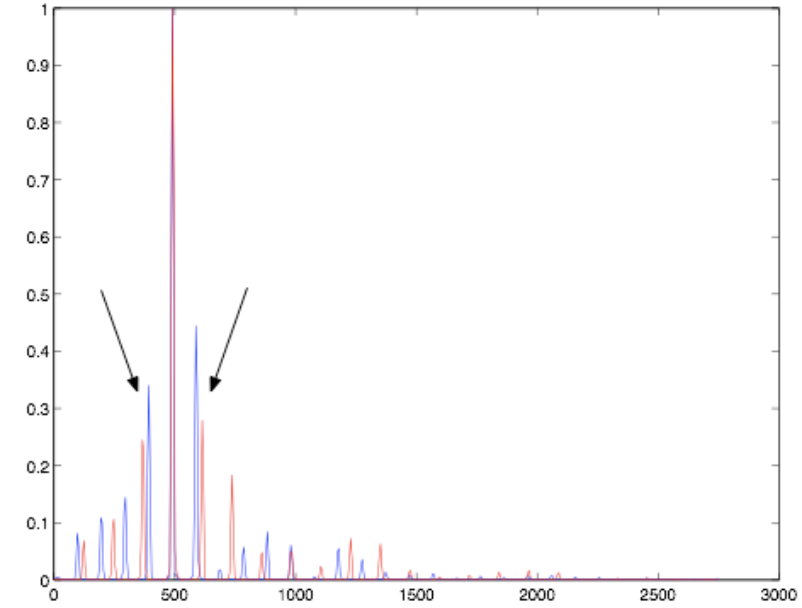
Further qualities

- Onset of partials
- Transients
- Balance of even/odd partials
- Sensory consonance/dissonance

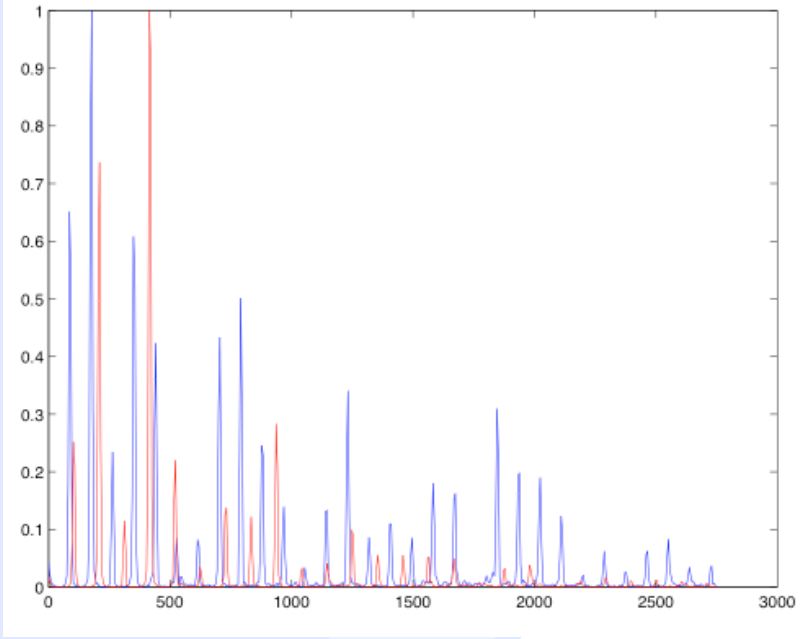
Timbre and Orchestration



Comparison of clarinet and cello spectra



Two bassoons at an interval of a major third



Two cellos at an interval of a major third

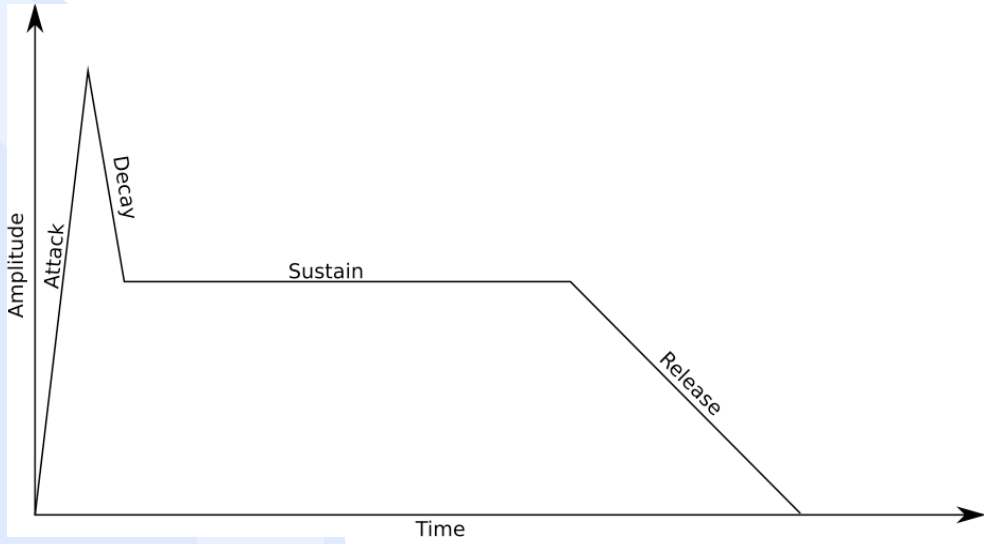
Fusion

- Why do not we hear spectra as chords?
  - Harmonic spectrum
  - Onset of partials in close temporal proximity
  - Partials move together

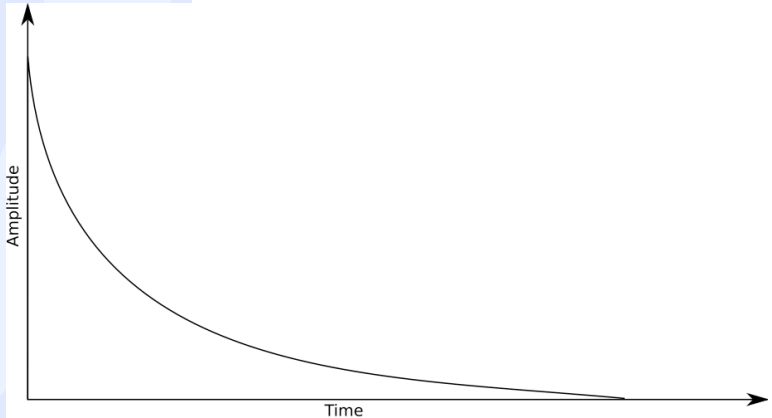
Example: Separation of a bell sound into three voices

Envelope

- ADSR model (e.g. wind instruments)
  - Attack
  - Decay
  - Sustain
  - Release



- Expontial Decay (e.g. piano or percussive instruments)

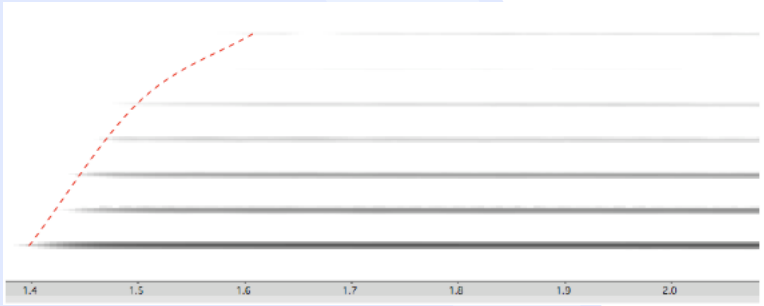


Attack

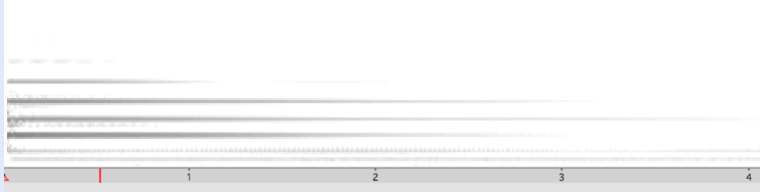
- The first milliseconds of the attack determine the impression of a sound to a large degree
- Attacks below 30 milliseconds sound percussive

Attack

- The onset of partials contributes tp the character of an instrument

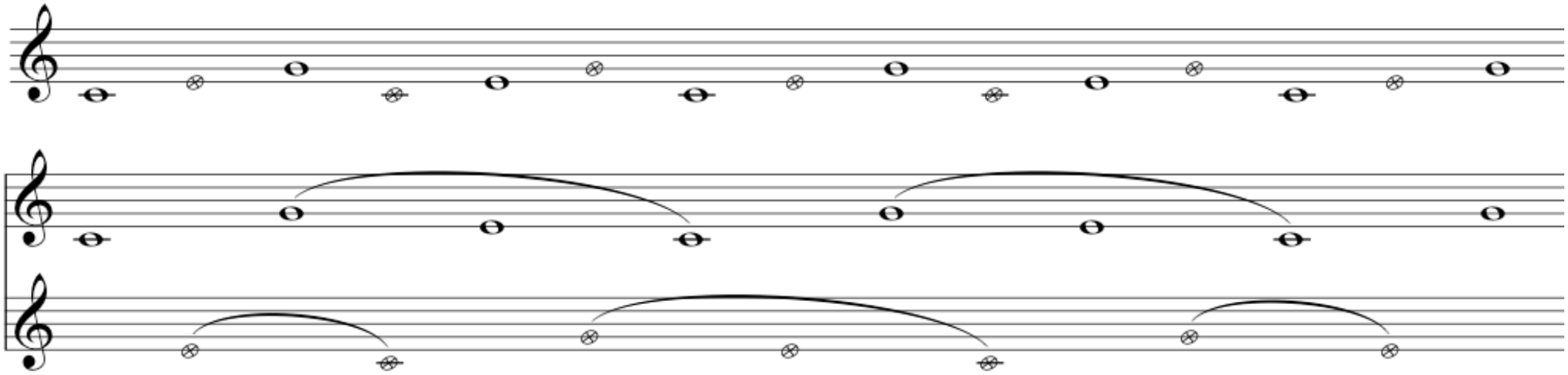


Clarinet with attack cut off resembles a bell

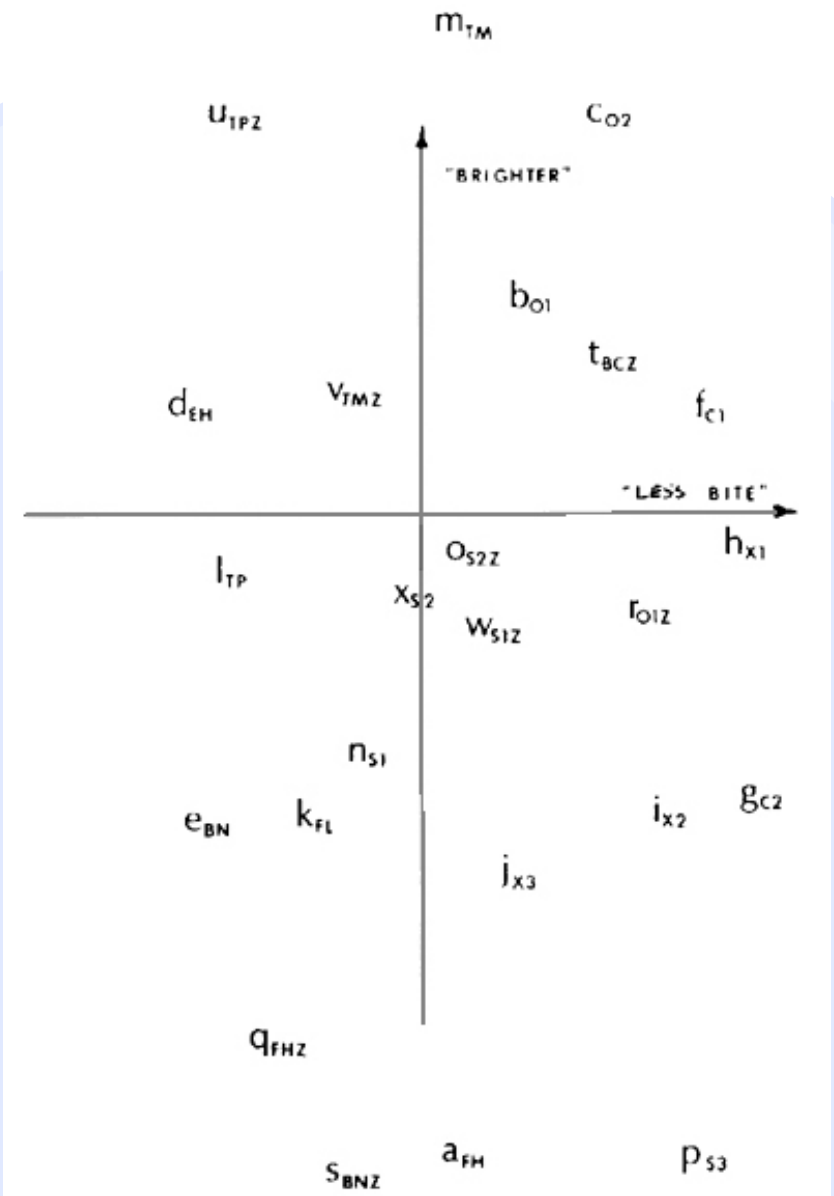


Timbre as a structural element

- Timbre space
- Stream segregation



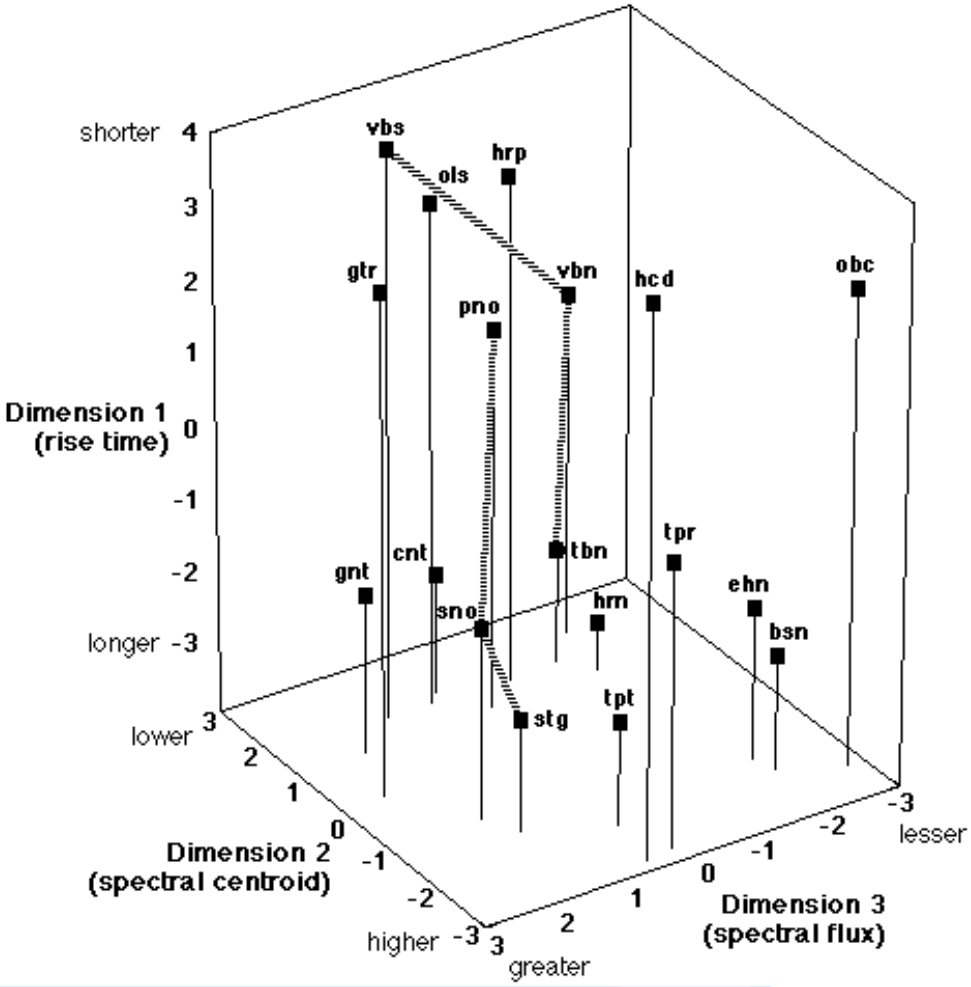
Timbre space



Two-dimensional timbre space

Abbreviations for stimulus points : 01, 02 = oboes, FH = French horn, BN = bassoon, C1 = E-flat clarinet, C2 = bass clarinet, FL = flute, X1 X2, X3 = saxophones, TP = trumpet, EH = English horn, S1 = cello played *sul ponticello*, S2 = cello played normally, S3 = cello played muted sul tasto, FHZ = modified FH with spectral envelope, BNZ = modified BN with FH spectral envelope, S1Z = modified S1 with S2 spectral envelope, S2Z = modified S2 with S1 spectral envelope, TMZ = modified TM with TP spectral envelope, BCZ = modified C2 with 01 spectral envelope, 01Z modified 01 with C2 spectral envelope.

Timbre space



Dimensions of three-dimensional timbre space

1. attack
2. centroid
3. flux = temporal behavior of spectral envelopes