Rhythm and Melody

Aspects of Language and Music

Dafydd Gibbon

Guangzhou, 25 October 2016
Orientation
Orientation - 1

• Language:
  • focus on speech, conversational spoken language
    – not written text
  • focus on complex behavioural performance
    – more than speculation on language cognition or ‘competence’

• Music:
  • focus on solo song
    – more than instrumental music
    – and not ‘written’ or orchestral music
  • focus on complex behavioural performance
    – more than speculation on musical cognition or ‘competence’

• Method:
  • discipline: more phonetic than linguistic
  • syncretistic: intuition plus measurement
• What is rhythm?
  • Ella Fitzgerald: “I have rhythm.”
    – Spoken English type of ‘foot-timed’ rhythm

• What is melody?
  • Bob Dylan: “The answer is blowing in the wind.”
    – Spoken English type of intonation-like melody

• Rhythm and melody:
  • other cultures, languages, registers:
    – West African dirges (funeral songs / chants)
    – Chinese popular songs: tone match in speech and song?
    – Children’s chants: speech or music?
    – Surrogates: whistled speech (e.g. calls, interjections)
Controversies
Controversies – musical relativity

• Are there universals of language and speech?
• Is there language-specific ‘musical relativity’?
  • does music shape language?
  • Does language shape music?
  • Does music shape thought?
  cf. ‘linguistic relativity’, the claim that language shapes thought

• A speculative example:
  – Robert Hall claimed
    • Elgar’s music is mostly popular in Britain because it is heavily influenced by Standard British English intonation:
      • very wide pitch range
      • sudden changes of pitch height (e.g. musical 7th interval)
Controversies – types of musical relativity

• Musical relativity:
  – Is music shaped by speech? - To some extent:
    – chant: adapted to restricted rhythms and melodies of speech
    – song: often adapted to a broader range of rhythms and melodies of speech
    – instrument: phonaesthetic imitation of speech rhythms and tonal melodies
    – surrogates: drumming, whistling with speech rhythms and tonal melodies
  – Is speech shaped by music? - To some extent:
    – music-like contours in greetings and calls - “Good morning!”, “Jooohnyy!”
    – song: speech rhythms and melodies adapted to musical conventions
Controversies – conventions of music and speech

• Speech and music are both
  • complex modes of human behaviour
  • complex modes of human cognition:

• Speech:
  • conventions shaped by local, especially family communation
  • formalised by public and written communication

• Music:
  • conventions shaped by social community activity:
  • increasingly formalised in larger communities: celebration, religion, courtship
Controversies – co-evolution of music and speech?

- Both speech and music may have
  - Shared phases in the evolution of behaviour
  - Shared phases in the evolution of cognition?

- A speculation on co-evolution:
  - first simple vocalisations and gestures
    - then sequential iteration leading to rhythm – synchrony with other bodily activities?
    - then parallel iterated signals
    - finally speech and music with complex recursive iterations
  - Compare language acquisition by children:
    - first rhythm and melody, then vocabulary and grammar
  - Compare animal behaviour:
    - simple rhythms of animal speech, from barking dogs to birds
    - simple melodies from birdsong to complex primate ape cries
Other Aspects of Language and Music

- Meaning in language and music
  - semantic: for example sound symbolism
    - such as imitating voices, animals, natural events
  - pragmatic:
    - for example emotions
      - It is claimed that music can express the emotions joy, tenderness, longing, coquetry, surprise, fear, complaint, scorn, anger, sarcasm
      - for example styles – classical, romantic, blues, ...

- But here we concentrate on sound patterns
Pitch (melody) – Spectrum (timbre) – Time (rhythm)
Pitch (melody) – Spectrum (timbre) – Time (rhythm)

Signal time domain ≈ waveform (oscillogram): top, black
Melody ≈ fundamental frequency (F0, f0, pitch track/trace): bottom, blue
Timbre ≈ spectrogram (harmonics/overtones, formants)
Visualising Speech Melody: “Good morning!”
Four ways of saying “Good morning!”

Visualisation with Praat phonetics software
Four ways of saying “Good morning!”

Pitch movements on vowels (syllable centres)

Visualisation with Praat phonetics software
Four ways of saying “Good morning!”

Approximate pragmatic meanings

Normal
Expecting interaction
Surprise encounter
Greeting at a distance

Visualisation with Praat phonetics software
Visualising Speech Rhythm
Visualising Speech Rhythm

Regular rhythm, ‘syllable timing’, ‘syllable isochrony’

Regular rhythm, ‘foot / stress timing’, ‘foot isochrony’
Speech Rhythm and Grammar

• Rhythm and phrasing:
  – Resolution of ambiguity of modifier scope:
    • old men and women will stay here
      – (old (men and women)) will stay here
      – ((old men) and women) will stay here
  – Resolution of ambiguity of operator scope:
    • he did not leave because he was tired
      – he did (not (leave because he was tired))
      – he did (not leave) because he was tired
  – Resolution of prepositional phrase attachment
    • I saw the man on the hill with a telescope
      – I saw (the man on the hill) with a telescope
      – I saw the man (on the hill with a telescope)
Speech Rhythm and Grammar

- Rhythm and focus:
  - Neutral focus:
    - I like red SHIRTS
  - Emphatic focus:
    - I **LIKE** red shirts
  - Contrastive focus:
    - Jack likes red SHIRTS
    - Jack likes RED shirts
    - Jack LIKES red shirts
    - JACK likes red shirts
    - JACK likes RED shirts

- Depending on the intensity of the pitch accent, these may be ambiguous
  - ... but not red HATS
  - ... but not BLUE shirts
  - ... but does not HATE red shirts
  - ... but not JIM,
Rhythm and Melody: Comparing Speech and Music
Spoken language influences music (but not always)

- **Song:**
  - spoken language may influence music in
    - rhythm
    - melody
  - but this is not always true
  - and may be completely wrong for instrumental music

- **English popular songs:** speech tends to influence music
  - **Rhythm:**
    - phrasing adapted to English grammar
    - accents adapted to English stress and focus
  - **Melody:**
    - local accents on syllables and words
    - global tunes and accents on phrases
Rhythm and Melody

• Spoken language and music share
  - melody
    • changes in fundamental frequency of signal over time
  - timbre
    • overtone (harmonic) pattern of signal:
      - voice: different vowels, different voice qualities
      - music: resonance qualities of instrument
  - rhythm
    • patterns of
      - sequences of stronger and weaker elements
      - more or less regular intervals between stronger elements
    • types
      - voice: stress timing, syllable timing, mora timing
      - music: 3/4, 4/
Rhythm

speech \ = ? \ music
Rhythm

speech ↔ music

talk ↔ song ↔ instrumental

=?
Rhythm

speech

= ?

music

talk

song

instrumental

rhythm of speech

= ?

rhythm of music
Melody

speech \Rightarrow \Box = ? \Rightarrow music
Melody

speech

= ? 

music

talk

song

instrumental
Melody

speech $\equiv ?$ music

talk

talk $\equiv ?$ instrumental

song

melody of speech $\equiv ?$ melody of music
Putting Things Together:
The Sounds of Language

The Sounds of Music
Speech (Spoken Language)

SPEECH

<table>
<thead>
<tr>
<th>tone</th>
<th>vowels (resonant)</th>
<th>consonants (noisy)</th>
<th>duration</th>
</tr>
</thead>
</table>

WORD
Speech (Spoken Language)

- intonation
- tone
- vowels (resonant)
- consonants (noisy)
- duration
- phrasing
Speech (Spoken Language)

Speech sounds

intonation  tone  vowels (resonant)  consonants (noisy)  duration  phrasing

WORD

SENTENCE
Speech (Spoken Language)

**SPEECH**

- **melody**
- **speech sounds**

- **intonation**
- **tone**
- **vowels (resonant)**
- **consonants (noisy)**
- **duration**
- **phrasing**

**WORD**

**SENTENCE**
Speech (Spoken Language)

Speech sounds

- melody
- rhythm

WORD
- intonation
- tone
- vowels (resonant)
- consonants (noisy)
- duration
- phrasing

SENTENCE
Speech (Spoken Language)

SPEECH

melody

timbre

rhythm

speech sounds

intonation
tone
vowels (resonant)
consonants (noisy)
duration
phrasing

WORD

SENTENCE
Speech (Spoken Language)

- **Speech Sounds**
  - **Melody**
  - **Timbre**
  - **Rhythm**

**Word**
- Intonation
- Tone
- Vowels (resonant)
- Consonants (noisy)
- Duration
- Phrasing

**Sentence**
Speech (Spoken Language)

SPEECH

- melody
  - intonation
  - tone
  - vowels (resonant)
  - consonants (noisy)
  - duration

- timbre
  - speech sounds
  - voice quality

- rhythm
  - phrasing

WORD

SENTENCE
From Speech to Music

MUSIC

- melody
- timbre
- rhythm

- tunefulness
- note
- instrument type
- duration
- phrasing

BAR
PHRASE
Music + Speech = Song

MUSIC

melody

timbre

tune

rhythm

vowels (resonant)

consonants (noisy)

speech sounds

phrase

instrument type

note

duration

phrasing

BARS

PHRASES
Parallel Signals in Speech and Music
Parallel ‘melodies’ in speech and music

- **Speech:**
  - 2 (or more) speakers in dialogue: usually sequential
  - multimodal streams:
    - locutions
      - distinctive features
    - prosody
      - global intonation
      - local tones
    - gesture

- **Music**
  - 2 (or more) musicians in orchestra / band: usually parallel
  - multimodal streams
    - text, lyrics
    - music
      - harmonies
    - accompanying behaviour

http://www.ted.com/talks/bobby_mcferrin_hacks_your_brain_with_music
**Rhythm (or lack of it)**

Speech (spoken language) with physical forms and semantic / pragmatic meanings

words, sentences
Parallel signal streams in communication

Choice of instruments
for production, transmission, perception

- melody
- overtones
- noise
- silence
Parallel signal streams in communication

Speech (spoken language)
with physical forms and
semantic / pragmatic meanings

words, sentences

Choice of instruments
for production, transmission, perception

melody

overtones

noise

silence
Melody

Lexical: contrast, structure, word formation

Tone
Chinese, Igbo, Pirahã, ...

Pitch accent
Japanese, Swedish

Prominence
English, German

Choice of instruments
for production, transmission, perception

--- overtones
--- noise
--- silence
Melody

Discourse: dialogue acts, turn-taking

Intonation

All languages – but in different ways

Choice of instruments
for production, transmission, perception

overtones
noise
silence
Melody in Song, an Example: Bob Dylan
Spoken language influences music (but not always)

- Discussion:
  - check the pitch trace in relation to grammatical categories

Bob Dylan, *The answer is blowing in the wind.*
Spoken language influences music (but not always)

• Discussion:
  - check the pitch trace in relation to grammatical categories

Bob Dylan, *The answer is blowing in the wind.*
Spoken language influences music (but not always)

Check the pitch pattern in relation to grammatical categories, noting:
- changes in pitch movement
- after each change, the direction of pitch movement
- (falling, rising, level)

Bob Dylan, *The answer is blowing in the wind.*
Musical Melody and English Grammar

Listen to and describe the way the phrases are expressed and separated:

the answer, my friend, is blowing, in the wind
Musical Melody and English Grammar

Listen to and describe the way the phrases are expressed and separated:

the answer, my friend, is blowing, in the wind
Rhythm in Song, an Example: Ella Fitzgerald
### Rhythm in Music

**Ella Fitzgerald, “I got rhythm”**

<table>
<thead>
<tr>
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| 0 | 13.32 |

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<th>I got rhythm</th>
<th>I got music</th>
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Dafydd Gibbon, Guangzhou, 25 November 2016
Rhythm in Music

Ella Fitzgerald, “I got rhythm”
Rhythm in Music

Ella Fitzgerald, “I got rhythm”
English Rhythm in Music

Ella Fitzgerald, “I got rhythm”

Foot timing

Special case: only unstressed syllables (anacrusis)
Musical Rhythm and English Grammar

Note that the musical structures ALMOST fit the grammatical structures!

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Ella Fitzgerald, “I got rhythm”
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*Ella Fitzgerald, “I got rhythm”*
Musical Rhythm and English Grammar

Note that the musical structures ALMOST fit the grammatical structures!

Ella Fitzgerald, “I got rhythm”
Universals of Melody?
Between Speech and Song

• ‘Call contours’
  - stylised, flat pitches
  - musical intervals, e.g. minor 3\textsuperscript{rd} (3 semitones)

• Chants:
  - childrens’ chants
    • it’s raining, it’s pouring, the old man’s snoring, ...
    • cowardy cowardy custard, your face is made of mustard
  - vendors’ sales chants
  - religious liturgical chants
  - rap
Universals of Melody: ‘Call Contours’
Universals of Melody: ‘Call Contours’
Universals of Melody: ‘Call Contours’

Table 1: Chant contour frequencies averaged over the accent-bearing syllable; chant contour ratios compared with just and tempered minor 3rd.

<table>
<thead>
<tr>
<th>associated locution</th>
<th>1st F0 level</th>
<th>2nd F0 level</th>
<th>F0 ratio</th>
<th>minor 3rd ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>hello</td>
<td>212</td>
<td>177</td>
<td>1.198</td>
<td></td>
</tr>
<tr>
<td>goodbye</td>
<td>201</td>
<td>168</td>
<td>1.196</td>
<td>1.2</td>
</tr>
<tr>
<td>Johnny</td>
<td>240</td>
<td>196</td>
<td>1.224</td>
<td>1.189</td>
</tr>
<tr>
<td>where are you</td>
<td>230</td>
<td>197</td>
<td>1.168</td>
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Universals of Melody: the Pentatonic Scale

Bobby McFerrin ‘playing’ an audience like a piano:

check your favourite search machine for a video clip with search key combinations like ...

Bobby McFerrin pentatonic
or
Bobby McFerrin Science Festival
Speculations and Conclusions
Speculations on Rhythm, Melody and Evolution

SHARED WITH BIRDS, ANIMALS

Simple sound events

Communicative rhythm: pulse modulation, iterative patterns

Communicative melody: frequency modulation, parallel patterns

Communicative timbre: speech, recursive patterns

Music: recursive patterns

Song

Increase in complexity over time
Summary and Conclusion

• Language and music many features
  – structural patterns:
    • linear
    • hierarchical
    • parallel
  – Language and music share functions:
    • identity:
      – individual
      – community
    • emotion

• But there are differences
  – which affect the speech-music relation in song
  – which may be due to partly independent evolution