

A Quick and Dirty Introduction to Musical Rhythm

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Course Overview

Lecture 1: Quick Intro to Rhythm

Basic concepts and psychological aspects

Lecture 2: What is Synchronization?

Models for coordination and synchronization

Lecture 3: Social Synchronization in Music

Humans and machines; Followers and leaders

Lecture 4: Virtuosity, a solo art(?)

Speed, synchronization, and executive function

Outline of Lecture 1

1. Rhythms, bad and good
2. What is the distinction between rhythm and meter?
3. What is a beat? Meter as entrainment
4. Perceptual limits of meter
5. Subjective rhythmization, accent, and listener added-value

Rhythm (*def.*)

Rhythm (from Greek ῥυθμός, *rhythmos*), generally means a movement marked by the regulated succession of strong and weak elements . . . this can apply to a wide variety of cyclical natural phenomena having a periodicity or frequency of anything from microseconds to millions of years.

-- Wikipedia, March 2014

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Rhythm (*def.*)

In the performance arts rhythm is the timing of events on a human scale; of musical sounds and silences, of the steps of a dance, or the meter of spoken language and poetry.

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Rhythm (*def.*)

Is this a rhythm?



Rhythm (*def.*)

Is this a rhythm?



Yes.

Any series of sounds has **some** rhythm, since:

- (a) If something is a sound it necessarily has some duration and
- (b) All durational sequences have a rhythmic structure (more or less repetitive, more or less complex, operating on certain time scales, etc.).

Rhythm (*def.*)

But rhythm also seems to admit degrees, as we can talk of something being “more” or “less” rhythmic.

So, let us examine some cases of good versus bad rhythms . . .

Are you a good rhythm,
or a bad rhythm?



Bad Rhythms



Bad Rhythms

1.1 Impossible Rhythms

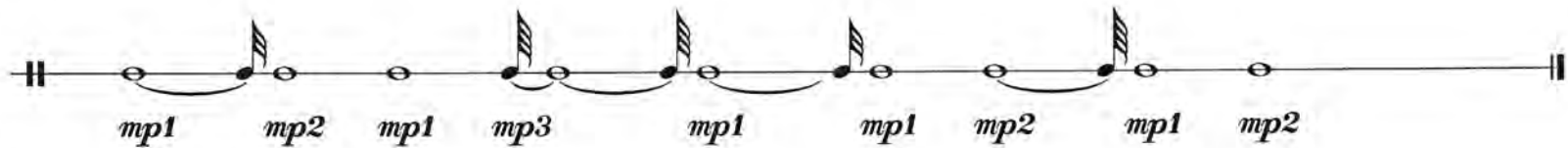
(a) Exceeding the scope of human perception.



Bad Rhythms

1.1 Impossible Rhythms:

(b) Exceeding the capacity for human discrimination.



Bad Rhythms

1.1 Impossible Rhythms

(c) Rhythms that are self-contradictory.

♩: 0 $\frac{1}{2}$ | 1 $\frac{1}{2}$ 2 $\frac{1}{2}$
: . : . : .

3 3 3
: . : . : .

♩: 0 $\frac{1}{3}$ $\frac{2}{3}$ | $\frac{1}{3}$ $\frac{2}{3}$ 2 $\frac{1}{3}$ $\frac{2}{3}$
 $\frac{1}{2} = \frac{2}{3}?$

Partly Bad Rhythms

1.2 Improbable Rhythms: Rhythms or meters that are rare in a particular style or culture.

(a) $9/8$ in Western Classical Music

1.1% of all examples in Barlow & Morgenstern (54.9% in simple duple meters)

(b) $3/4$ in Mainstream Rock Music

N.B. Common in Country/Bluegrass music, given prominence of Waltzes

(c) Non-isochronous beats in western music more generally

Not Really Bad Rhythms

1.3 Misunderstood rhythms

Rhythms one cannot hear due to enculturation.

Cholita Chapareña

(A)



(not on sound example) (Cho - li - ta Cha - pa - re - ñi - ta, may - lla - pi - taq kaw - kushan - ki)
Saw - si - llu - run - chu kas qa - ni? Ku - muy - kus - pa wa - qa - nay - paq.



Chay - paq ka - ni Mar - gar - ri - tay, a - si - kus - pa qha - wa nay - paq. D.C.



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(B)



Saw - si - llu - run - chu Kasqa - ni Kumuy - kus - pa wa - qa - nay - paq



Chay paq - ka - ni Mar - ga - ri - tay a - si - kus - pa qha - wa - nay - paq. D.C.



Not My Rhythms

1.4 Rhythms I just don't like.

(a) Moiseiwitch's overdone rubato



From Chopin's Polonaise #9 in Bb Major, Op. 71/2

(b) Techno's uber-predictability



From "Woo-Boost" by Rusko (dubstep example)

(c) Boulez's hyper-complexity



From *Structures II* for Two Pianos

“Bad” Rhythms

Summary of Rhythmic Badness:

- Rhythms that are impossible
- Rhythms that are improbable
- Rhythms that are just misunderstood
- Rhythms that one just doesn't like

Good Rhythms



Degrees of Rhythmic Goodness

- Tangle Eye, “Tangle Eye Blues” (recorded by at the Parchman prison farm, 1947)



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- An example of “Dubstep” (from Wikipedia)



Degrees of Rhythmic Goodness

- It does make sense to speak of “Degrees” of rhythmicity, or that a sequence is more or less rhythmic, but . . .
- there is more to rhythmic goodness than just repetitiveness/isochrony (otherwise dubstep would be the “best” rhythm)
- there is more to rhythmic goodness than predictability or precision.

Terminological Traps

“Beat” (“Tactus,” “Takt” oder “Taktteile”)
is a problem word.

Metrically, it refers to a time-point (a temporal location) . . . but in general rhythmic parlance, many musicians use it to refer to:

Terminological Traps

- A physical gesture (“beating time”)
- The rate of those articulations (tempo)
- The time-signature used to notate a particular metrical type.
- A sense of motion or speed (“groove”)
- A shorthand for a rhythmic pattern (esp. in hip-hop, as in “sampling beats”)

Terminological Traps

What beats really are: an subjective/ endogenous response to temporal regularities (of a certain time scale, between 6-.5hz) in the environment.

Beats are the hallmark of entrainment, a temporal resonance between a person and rhythms in their environment, rhythms that are often created by other people.

Beat Perception is Not Passive

We readily interpolate elements, even when onsets are missing in the music . . .



And even when there is “rhythmic interference”



Entrainment

“In response to a periodic input, a physiological rhythm may become entrained or phase-locked to the periodic stimuli, such that for each N cycles of the input there are M cycles of the second rhythm.”

(Glass and Mackey 1988)

Human entrainment involves neural oscillations of our sensorimotor system, both in terms of attention and covert or overt action.

Meter as Entrainment

- Entrained rhythms are **self-sustaining** yet inter-dependent.
- Meter is entrainment in a musical context.
- Meter involves a coordinated **set** of attentional periodicities, which may (and usually do) direct motor behaviors.
- Our metric behaviors are over-learned, practiced responses to music--our metrical oscillators are “tuned” via enculturation.

The Meter-Rhythm Distinction

- Meter is comprised of endogenous “beats”
- Beats are abstracted from the soundstream by the listener
- Beats are organized into cyclical measures
- Meter involves when events happen
- Groups are comprised of phenomenal durations
- Durations are based on the inter-onset interval between sounds
- Durations are organized into groups, which may or may not repeat
- Groups involve what events happen

Some Metric Terms

Metrical Hierarchies involve:

- Subdivisions of the beat (Taktglieder)
- Beats (Takt)
- Bars (Takt/Metrum)

Some Metric Terms

Metrical Hierarchies involve:

- Subdivisions of the beat
- Beats
- Bars (cyclical patterns of beats)

Basic metrical terminology:

	Binary Subdivision	Ternary Subdivision
Binary Beat Cycle	Simple Duple (4/4)	Compound Duple (6/8)
Ternary Beat Cycle	Simple Triple (3/4)	Compound Triple (9/8)

Rhythm-Meter Summary

- Musicians have developed a rich vocabulary for representing and describing musical rhythms.
- These representations and descriptions are grounded in concerns with how these rhythms are produced--of what actions need to be performed and when.
- Vocabularies and notational representations are short-hands for more complex sounds and actions; they are often inaccurate as representations of their actual structure.

Rhythm-Meter Summary

- Rhythm and meter are distinct aspects of music's temporal structure and our experience of it.
- Rhythm involves phenomenal durations and their organization into groups.
- Meter involves our endogenous sense of beats and beat cycles, a musically-specific manifestation of our more general capacity for entrainment.
- Meter and Rhythm interact—may be mutually reinforcing, or contradictory.

A Tempo Demonstration

- This Performance is TOO FAST
- This Performance is TOO SLOW
- This Performance is JUST RIGHT



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A Tempo Demonstration

- This Performance is TOO FAST
 - This Performance is TOO SLOW
 - This Performance is JUST RIGHT
- A sense of rhythmic motion requires at least one periodicity in the 300-1500ms range.

Perceiving Number and Duration

- 100ms required for determination of quantity (quadruplet versus quintuplet); also the limit for subjective rhythmization (Bolton 1894).
- 100ms required to hear durational differences (Hirsh, Monohan, et al 1990).

3-4-5 . . . @70ms 

3-4-5 . . . @120ms 

70ms Long-Short 


120ms Long-Short 

Perceiving Number and Duration


- 100ms required for determination of quantity (quadruplet versus quintuplet); also the limit for subjective rhythmization (Bolton 1894).
- 100ms required to hear durational differences (Hirsh, Monohan, et al 1990).

→ BUT 100ms is too fast for beat perception.

Perceiving Connected Motion

- You can clap along with this: 
- And you can clap along with this:
- But not to this:

Perceiving Connected Motion

- You can clap along with this:
- And you can clap along with this: 
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Perceiving Connected Motion

- You can clap along with this:
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Perceiving Connected Motion

- You can clap along with this:
- And you can clap along with this:
- But not to this:
 - 1500ms is the limit for connected motion and anticipatory attending and hence beat perception.

Different Levels; Different Rules


- We are able to hear rhythmic relationships only with a fairly restricted range (100ms to 5-6 seconds)—beyond that, we lack any direct apprehension of “rhythm” in the normative sense of the word.
- Within this range, the temporal topography is not uniform:
 - Very short intervals grasped qualitatively
 - Beat-level intervals grasped quantitatively
 - Larger intervals are composites of 2 or more beats


Different Levels, Different Rules

- We do encounter faster musical events—trills and grace notes—but perceptually (and hence gesturally) these are very different from patterns of duration $> 100\text{ms}$
- And of course we encounter very slow events ($>1.5\text{-}2.0\text{ sec}$), but they are heard in isolation, and not connected in terms of motion or gesture.

Rhythmic Accents

A demonstration: do you hear 2s or 3s?


- Example 1: 

- Example 2: 

- Tempo Effects:

 - 3.1 

 - 3.2 

 - 3.3 

Subjective Accents

- **Entrainment** leads us to interpolate beats that are not phenomenally articulated in the music.
- **Subjective rhythmization** leads us to hear certain sounds as accented, even when they are not phenomenally differentiated in terms of duration or loudness.

Rhythm Perception Summary

1. Rhythmic perception is active, and involves sensorimotor entrainment.
2. Patterns of grouping are phenomenal; meter is endogenous.
3. 100ms, 300ms, 600ms, 1500ms.
4. Rhythmic patterns are not given, but emerge through the interplay of our perception and enculturated cognition.

End of First Lecture

Next: Synchronization

Subjective Accents

Pitch (melody) can affect grouping:

- Melodies in different registers:

- Auditory Stream Segregation



- Melodic peaks and dips

- Regular contour → regular groups



- Irregular contour → ???



Some Rhythmic Terms

Rhythmic Elements, or a question of proportions:



Musical notation expresses durational relations in terms of integer ratios (1:2, 1:3, 2:3), but as we will see, these do not occur in actual performances.

Some Rhythmic Terms

Rhythmic Elements, or a question of proportions:



Rather, notation represents durational **categories**, and these are maintained in performance.

Some Rhythmic Terms

Rhythmic groups: a question of boundaries



Some Rhythmic Terms

Rhythmic groups: a question of boundaries



All three melodies use a Long-Short-Short pattern of durations, but each has the group boundary in a different place: (a) L-S-S|L-S-S, (b) S-L-S|S-L-S, or (c) S-S-L|S-S-L.

Some Rhythmic Terms

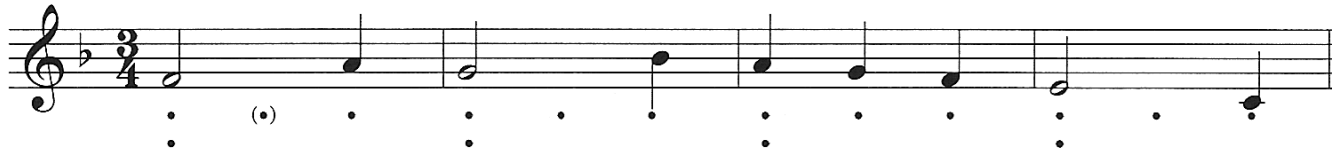
Rhythmic groups: a question of boundaries



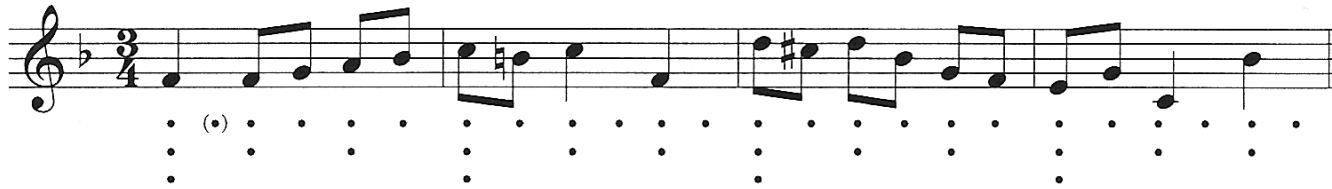
Note in all three, the long note is always on the downbeat; this does not change. Rather, it is whether the one or both short notes are heard as a **pick up** or **anacrusis** to the long, that is, whether the group starts with an upbeat, or on the downbeat.

Some Metrical Terms

Metrical Hierarchies can vary in
“thickness”



A musical staff in 3/4 time with a key signature of one flat. The melody consists of quarter notes: G4, A4, Bb4, A4, G4, F4, E4, D4, C4. Below the staff, a series of dots indicates a metrical hierarchy where each note is aligned with a dot, and a circled 'o' is placed above the first dot.



A musical staff in 3/4 time with a key signature of one flat. The melody consists of eighth and quarter notes: G4, A4, Bb4, A4, G4, F4, E4, D4, C4, Bb4, A4, G4, F4, E4, D4, C4. Below the staff, a series of dots indicates a metrical hierarchy where each note is aligned with a dot, and a circled 'o' is placed above the first dot.



Subjective Accents

Regularity and spacing of the groups matters:

- Irregularly spaced duplets:



- Regular, widely spaced duplets:



- Closer duplets:



- Very close duplets:



Subjective Accents

Regularity and spacing of the groups matters:

- Irregularly spaced triplets:



- Regular, widely spaced triplets:



- Closer triplets:



- Very close triplets:

