Microrhythm depends on sound qualities: Investigating sound–timing interaction across disciplines and cultures

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[collage of different sounds]
Microrhythm vs. Microtiming

• *Microtiming* (also expressive timing, swing timing, etc.) has been much studied over the past 50 years (Bengtson & Gabrielsson, Clarke, Repp, etc.)
  • Focus on variations (deviations from isochrony) in the onset timing of notes (“IOI” as the variable of interest)
• *Microrhythm* is a broader term which includes microtiming, as well as;
  • Sound shape (ASDR, timbre, center frequency, etc.)
  • Motional/dynamic aspects of a sound (“Grooviness”)
  • Listener response, including (a) endogenous meter, and (b) enculturation
TIME: Timing and Sound in Musical Microrhythm

Main Research Questions of the TIME Project:

• What aspects of a sound mark its temporal position?
  o How does the “what” a sound is affect “when” it is perceived to occur?

• How do sonic parameters affect the tolerance for the perception of synchrony, as well as the location of a sound in a metrical context?
  o Parameters: ASDR, overall intensity, timbre, etc.

• How might the “same” sound be heard in different musical contexts, and by listeners with different musical backgrounds/expertise?
TIME: Timing and Sound in Musical Microrhythm

Research Strategies of the TIME Project

• Develop experimental methods for studying microrhythm perception
  o Explore the effects of task and stimulus presentation
• Use a systematic and varied set of stimuli in perceptual studies
  o Control for acoustic factors in a musically-sensitive way
• Investigate the effects of enculturation and expertise
  o Different participant groups based upon musical expertise
• Observational and Ethnographic Studies
  o Attend to what musicians do, and how they describe what they do.
What is a P-Center, or “When” is a Note?

Top panel: acoustic onsets are isochronous; Bottom: P-centers are isochronous

The Beat Bin, or How “Wide” is the “When”? 
Methodological Studies


Methodological Studies

• Experimental *tasks* include synchronous tapping as well as click alignment with looped presentation of stimuli
  o Different visual interfaces explored with click task
  o In phase vs. antiphase responses explored with click task
  o Differences in sensitivity (i.e., width of the beat bin) investigated in click alignment vs. tapping tasks.
Perceptual Studies: Acoustic Factors


• Present listeners with real and artificial stimuli which systematically vary in *onset* (fast vs. slow), *duration* (short vs. long), and *pitch/frequency* (high vs. low)
The Overall Result . . .
A More Fine-Grained Result
Perceptual Studies: Expertise

Perceptual Studies: Expertise

• Same stimulus design and task as previous experiments
  o Natural instrumental sound-stimuli selected to match particular participants’ backgrounds

• In the first experimental study, participants were experts in different instrumental music genres: Jazz, Norwegian Folk Music, and EDM/Hip-Hop music producers

• In a second experiment expert classical and jazz vocalists were participants, using natural vocal stimuli (modified in terms of attack) rather than instrumental sounds
Perceptual Studies: Expertise

Expert instrumentalists’ mean p-center location by participant group, click alignment task; stimulus is long fiddle sound

Expert vocalists’ mean p-center location by participant group, click alignment task; stimulus is “A” vocal syllable
Performance Studies: What Musicians Do

Performance Studies: What Musicians Do

• Experimental studies used rhythm-section musicians (drums, guitar, or bass) playing with a click track or backing track
  o Audio and MoCap data from trials recorded
• When asked to produce musical sounds/patterns with different rhythmic “feels” (e.g., on-the-beat, laidback, pushed), musicians alter the microrhythmic features of the sounds
  o Both IOI and sound-shape are affected
• While timing (IOI) was the primary cue, musicians also varied intensity (SPL) and frequency components/brightness (spectral centroid) as well as the duration of sounds to perform the task
Performance Studies: What Musicians Do
Ethnographic Studies: What Musicians Say

Ethnographic Studies: What Musicians Say

- Interviewed Jazz, Folk, Samba, and EDM/Hip-Hop Musicians/Producers
- All of our interviewees were concerned with both the shaping of individual sounds, as well as their placement relative to other sounds
- Many interviewees recognized that sounds with a slow/soft attack afford a wider range of temporal positionings that nonetheless appear to be “in time”—that is, they have wider beat bins
- Discourse about groove is broadly informed by a holistic view of microrhythm, and interviewees tended to talk about groove using bodily and movement-related metaphors
  - Other terms/metaphors used: viscosity, friction, lifting, flowing, balance, tension/relaxation
Main Findings of the *TIME* Project

- Sonic parameters (esp. attack and duration) influence the perception of temporal relationships (P-center and beat bin) in a surprisingly systematic way.
- Musicians are highly aware of these effects.
- The effects of sonic parameters are modulated by musical expertise.
- Expert musicians systematically alter sonic parameters when playing with different microrhythmic feels (early, onbeat, late).
- These alterations are reflected in sound-producing and sound-accompanying gestures.
Broader Implications/Lessons from *TIME*

• Avoid over-generalizing from a narrow set of stimuli, a single experimental task, and a particular participant population
  o All “Expert Musicians” are not alike . . .

• Understand the nuances of the experimental design: a synchronization task isn’t just sonic alignment, but also
  o Creating a particular sonic blend between the sounds involved
  o Creating a particular rhythmic feel
  o Coordinating actual and virtual actions (perception-action coordination)
Broader Implications/Lessons from TIME

• The Importance of Cross-Cultural research
  o Allows one to disentangle general vs. culture-specific findings
• Multi-disciplinary research designs ensures that results are valid beyond the research traditions that produced them
• Successful cross-cultural and multi-disciplinary projects require a research team that is itself cross-cultural and multi-disciplinary, involving hard science, social science, and humanistic approaches
Thank you for your kind attention
Supplementary slides
## Integrated Results

<table>
<thead>
<tr>
<th>Micro-rhythmic feel</th>
<th>Informant discourse</th>
<th>Acoustic properties (compared to “On-the-beat”)</th>
<th>Perceptual properties</th>
<th>Sound-producing action (compared to “On-the-beat”)</th>
<th>Body posture</th>
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<tr>
<td>Laid-back</td>
<td>• Soft attacks</td>
<td>• Later onset timing</td>
<td>• Late P-center</td>
<td>• Slower and longer motion</td>
<td>• Most upright position (non-sig. change from on-the-beat)</td>
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<td></td>
<td>• “Floating” feel</td>
<td>• Longer attack</td>
<td>• Wide beat bin</td>
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<tr>
<td></td>
<td>• Heavy, “fat” sounds</td>
<td>• Longer total duration</td>
<td>• Darker sound</td>
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<tr>
<td></td>
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<td>• Lower spectral centroid</td>
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<tr>
<td>Pushed</td>
<td>• Sharp attacks</td>
<td>• Early onset timing</td>
<td>• Early P-center</td>
<td>• Faster and shorter motion</td>
<td>• Forward-leaning</td>
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<td></td>
<td>• High precision</td>
<td>• Increased intensity</td>
<td>• Narrow beat bin</td>
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<td></td>
<td>• “Fast” sounds</td>
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<td>• Brighter sound</td>
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</table>
Perceived microrhythmic feel (i.e., laid-back, on-the-beat, pushed)

Temporal

Acoustic parameters

Sonic

Onset
Duration
Attack
Shape
Intensity
Timbre
Future work

• Follow-up study on effects of expertise (classical and jazz singers)

• Ongoing study on neurophysiological mechanisms underlying beat bin precision and whether they are under top-down control

• Ongoing study on how the general sonic context influences perceived location and variability

• Ongoing study on the P-center and beat bins of compound sounds
P-Centers are Hard to Pin Down