



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

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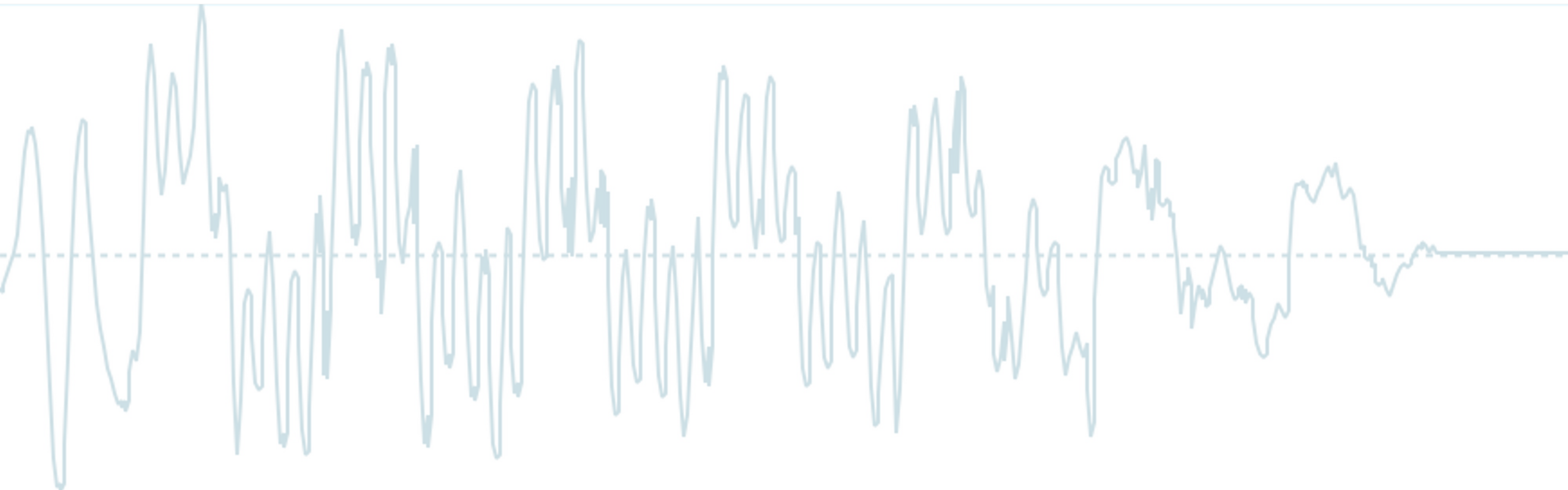


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[collage of different sounds]

Microhythm 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)
- *Microhythm* 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?
 - 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?
 - 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?

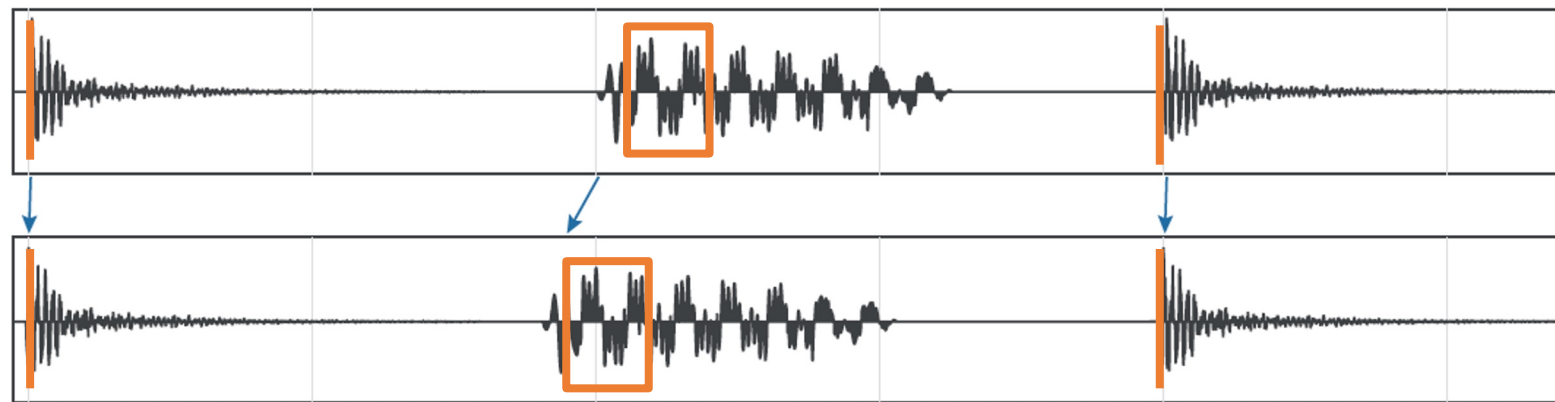
TIME: Timing and Sound in Musical Microrhythm

Research Strategies of the TIME Project

- Develop experimental methods for studying microrhythm perception
 - Explore the effects of task and stimulus presentation
- Use a systematic and varied set of stimuli in perceptual studies
 - Control for acoustic factors in a musically-sensitive way
- Investigate the effects of enculturation and expertise
 - Different participant groups based upon musical expertise
- Observational and Ethnographic Studies
 - 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

- Lartillot, O., Nymoen, K., Câmara, G. S., & Danielsen, A. (2021). Computational localization of attack regions through a direct observation of the audio waveform. *Journal of the Acoustic Society of America*, 149(1), 723–736. DOI: 10.1121/10.0003374
- London, J., Nymoen, K., Langerød, M. T., Thompson, M. R., Code, D. L. & Danielsen, A. (2019). A comparison of methods for investigating the perceptual center of musical sounds. *Attention, Perception & Psychophysics*, 81(6), 2088–2101. DOI: 10.3758/s13414-019-01747-y
- Nymoen, K., Danielsen, A., & London, J. (2017). Validating attack phase descriptors obtained by the Timbre Toolbox and MIRtoolbox. In *Proceedings of the SMC Conferences* (pp. 214–219). Aalto University, Finland.
- Sioros, G., Câmara, G. Schmidt, & Danielsen, A. (2019). Mapping timing strategies in drum performance. In A. Flexer, G. Peeters, J. Urbano, & A Volk (Eds.), *Proceedings of the 20th International Society for Music Information Retrieval Conference, ISMIR 2019*. https://archives.ismir.net/ismir2019/2019_Proceedings_ISMIR.pdf

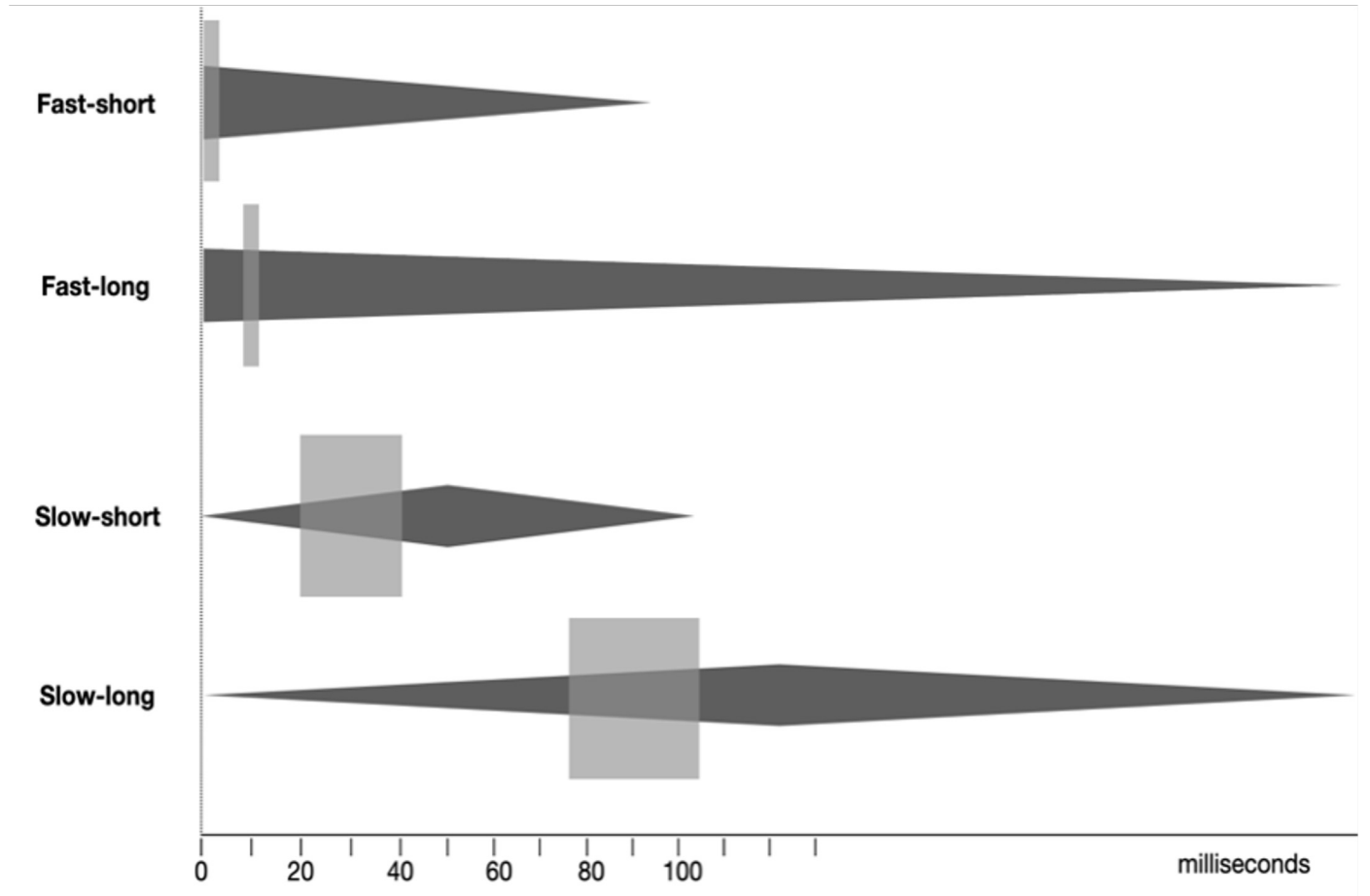
Methodological Studies

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

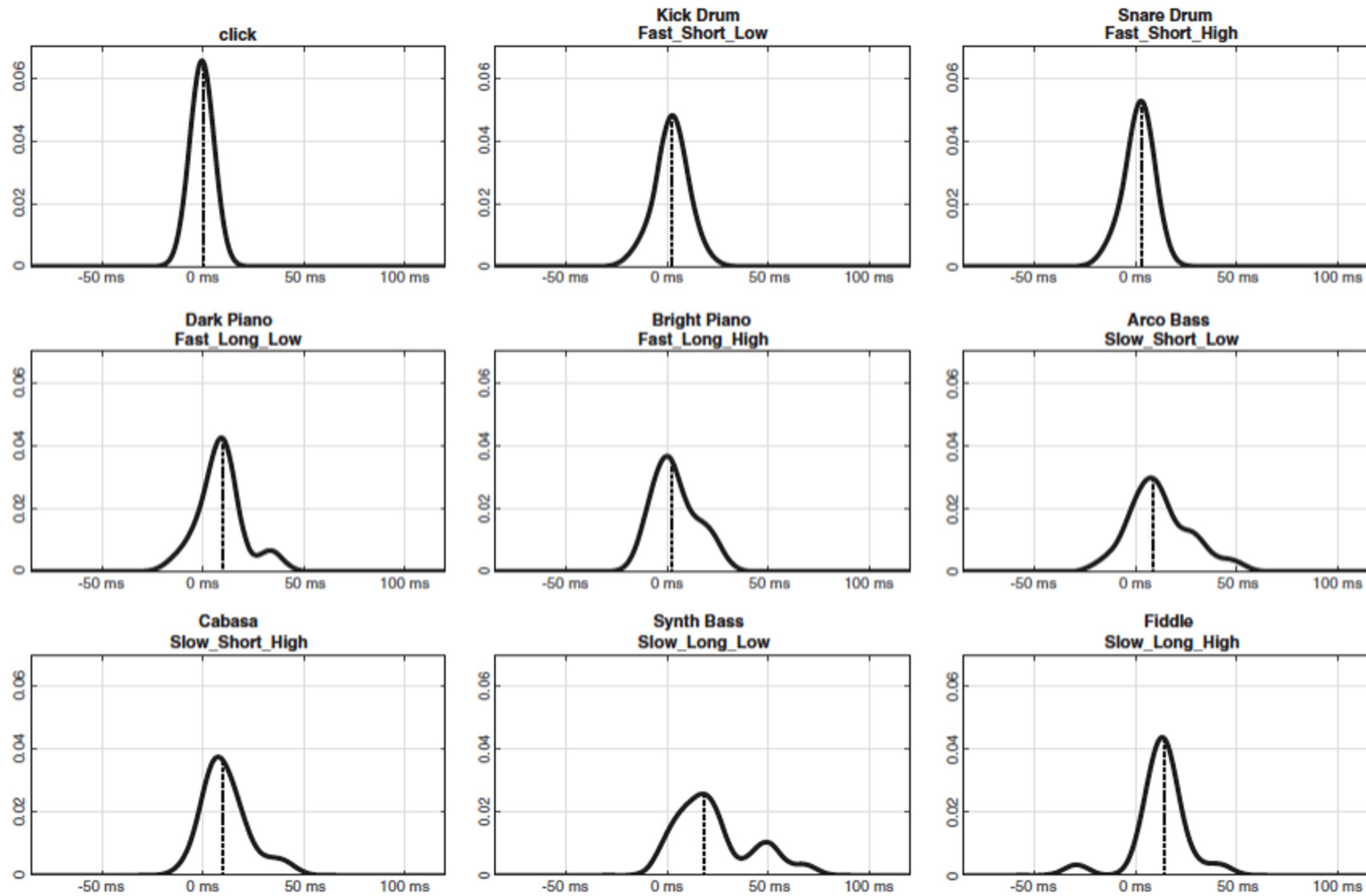
Perceptual Studies: Acoustic Factors

- Danielsen, A., Nymoén, K., Anderson, E., Câmara, G. S., Langerød, M. T., Thompson, M.R., & London, J. (2019). Where is the beat in that note? Effects of attack, duration, and frequency on the perceived timing of musical and quasi-musical sounds. *Journal of Experimental Psychology: Human Perception and Performance*, 45(3), 402–418. DOI: 10.1037/xhp0000611
 - 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



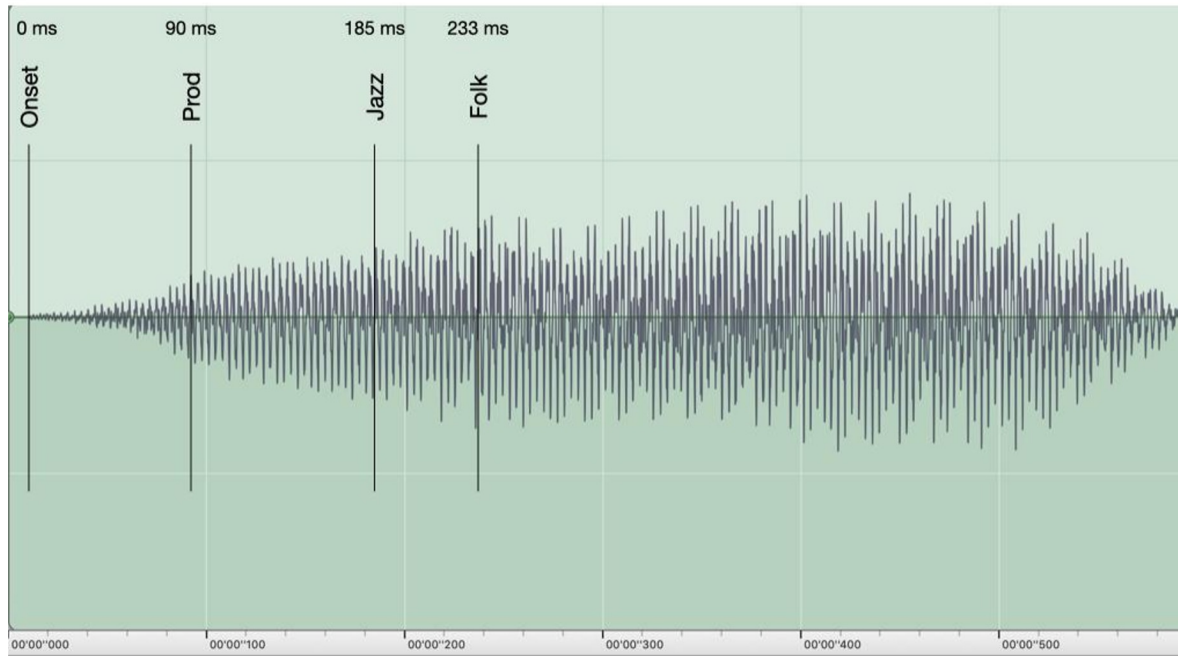
Perceptual Studies: Expertise

- Danielsen, A., Nymoene, K., Langerød, M. T., Jacobsen, E., Johansson, M., & London, J. (2021). Sounds familiar (?): Expertise with specific musical genres modulates timing perception and micro-level synchronization to auditory stimuli. *Attention, Perception, & Psychophysics*. DOI:10.3758/s13414-021-02393-z
- Danielsen, A., Paulsrud, T.S., & London, J. (forthcoming). The influence of vocal expertise on the perception of musical microrhythm: Acoustic, psychoacoustic, and cultural factors.

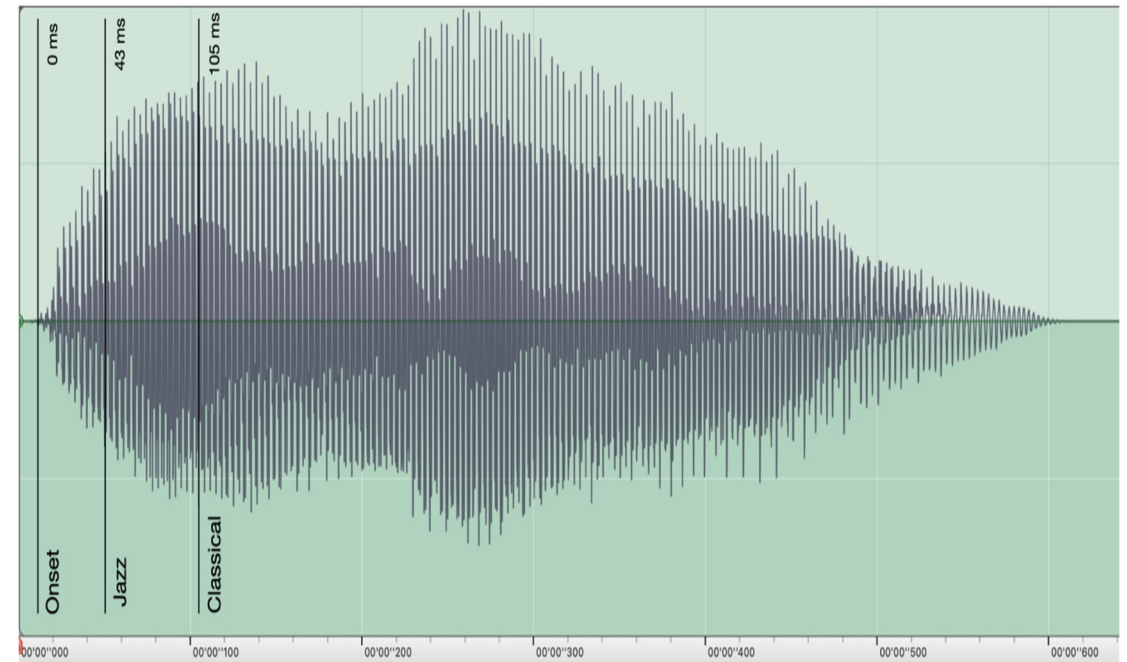
Perceptual Studies: Expertise

- Same stimulus design and task as previous experiments
 - 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

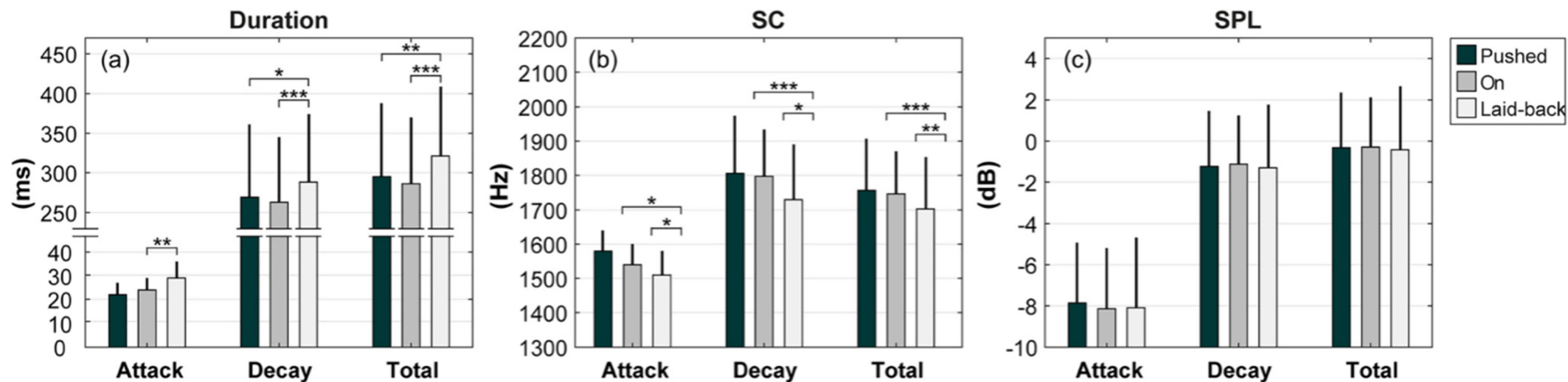
Performance Studies: What Musicians Do

- Câmara, G. S., Nymoén, K., Lartillot, O., & Danielsen, A. (2020a). Effects of instructed timing on electric guitar and bass sound in groove performance. *Journal of the Acoustic Society of America*, *147*(2), 1028–1041. DOI: 10.1121/10.0000724
- Câmara, G. S., Nymoén, K., Lartillot, O., & Danielsen, A. (2020b). Timing is everything . . . or is it? Effects of instructed timing style, reference, and pattern on drum kit sound in groove-based performance. *Music Perception*, *38*(1), 1–26. DOI: 10.1525/mp.2020.38.1.1
- Câmara, G. S., Sioros, G., & Danielsen, A. (2022). Mapping timing and intensity strategies in drum-kit performance of a simple back-beat pattern. *Journal of New Music Research*, *51*(1). DOI: 10.1080/09298215.2022.2150649
- Câmara, G. S., Sioros, G., Nymoén, K., Haugen, M. R., & Danielsen, A. (in press). Sound-producing actions in guitar performance of groove-based microrhythm. *Empirical Musicology*.
- Haugen, M. R., & Danielsen, A. (2020). Effect of tempo on relative note durations in a performed samba groove. *Journal of New Music Research*, *49*(4). DOI: 10.1080/09298215.2020.1767655
- Haugen, M. R., Câmara, G. S., Nymoén, K., Danielsen, A. (2023). Instructed timing and body posture in guitar and bass playing in groove performance. *Musicae Scientiae*. DOI: 10.1177/10298649231182039

Performance Studies: What Musicians Do

- Experimental studies used rhythm-section musicians (drums, guitar, or bass) playing with a click track or backing track
 - 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
 - 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

- Brøvig-Hanssen, R., Sandvik, B. E., & Aareskjold-Drecker, J. M. (2020). Dynamic range processing's influence on perceived timing in electronic dance music. *Music Theory Online*, 26(2). DOI: 10.30535/mto.26.2.3
- Brøvig, R., Sandvik, B., Aareskjold-Drecker, J., & Danielsen, A. (2021). A grid in flux: Sound and timing in electronic dance music. *Music Theory Spectrum*, 44(1), 1–16. DOI: 10.1093/mts/mtab013
- Danielsen, A., Johansson, M., Brøvig, R., Sandvik, B., & Bøhler, K. K. (2023). Shaping rhythm: Timing and sound in five groove-based genres. *Popular Music*, 39(1). DOI: 10.1017/S0261143023000041
- Jacobsen, E., & Danielsen, A. (forthcoming). 'Sharp' or 'soft': Shaping microtiming through sound in contemporary jazz rhythm performance. *Journal of Jazz Studies* (under review)
- Johansson, M. (2022). Timing–sound interactions: Groove-forming elements in traditional Scandinavian fiddle music. *Puls*, 7.
- Oddekalv, K. A. (2022). *What makes the shit dope? The techniques and analysis of rap flows* [Unpublished doctoral dissertation]. University of Oslo

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
 - All “Expert Musicians” are not alike . . .
- Understand the nuances of the experimental design: a synchronization task isn’t just sonic alignment, but also
 - Creating a particular sonic blend between the sounds involved
 - Creating a particular rhythmic feel
 - Coordinating actual and virtual actions (perception-action coordination)

Broader Implications/Lessons from *TIME*

- The Importance of Cross-Cultural research
 - 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

<i>Micro-rhythmic feel</i>	<i>Informant discourse</i>	<i>Acoustic properties (compared to “On-the-beat”)</i>	<i>Perceptual properties</i>	<i>Sound-producing action (compared to “On-the-beat”)</i>	<i>Body posture</i>
Laid-back	<ul style="list-style-type: none"> • Soft attacks • “Floating” <u>feel</u> • Heavy, “fat” sounds 	<ul style="list-style-type: none"> • Later onset timing • Longer <u>attack</u> • Longer total duration • Lower spectral centroid 	<ul style="list-style-type: none"> • Late P-center • Wide beat bin • Darker sound 	<ul style="list-style-type: none"> • Slower and longer motion 	<ul style="list-style-type: none"> • Most upright position (non-sig. change from on-the-beat)
Pushed	<ul style="list-style-type: none"> • Sharp attacks • High precision • “Fast” sounds 	<ul style="list-style-type: none"> • Early onset timing • Increased intensity 	<ul style="list-style-type: none"> • Early P-center • Narrow beat bin • Brighter sound 	<ul style="list-style-type: none"> • Faster and shorter motion 	<ul style="list-style-type: none"> • Forward-leaning

**Perceived microrhythmic feel
(i.e., laid-back, on-the-beat, pushed)**



Onset

Duration

Attack

Shape

Intensity

Timbre

Temporal

Sonic



Acoustic parameters

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

