Music Cognition between Theory and Experiment

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Goals and Scope

Music is a fascinating and complex aspect of cognition. When listening to music, listeners may experience complex structural relations, many of which are characterized in great detail by music-theoretical accounts. Such cognitive experience of structure in music, however, presents many challenges for empirical investigation: structural interpretations are the result of an inference on the part of the listener, resulting in ambiguous interpretations that listeners cannot often report explicitly. As a comparison, language comprehenders are also sensitive to the syntactic structure of sentences, and psycholinguistic research has an extensive track-record in investigating what representations of syntactic structure look like, and how they are formed in real-time processing. Could we achieve a similar understanding for music too? The goal of the symposium is to reflect on the challenges and prospects of such an endeavour: What can we learn from behavioural and brain-imaging experiments about the cognitive reality of musical structures? How do empirical observations pertaining to prediction and processing complexity relate to theoretical frameworks of musical structure?

The symposium will consist of four talks followed by a round-table discussion. The talks approach the empirical investigation of music processing by drawing on a wide range of perspectives and paradigms. In the first talk, John E. Drury will focus on attention and modularity to offer a novel perspective on the interaction of musical and linguistic processing as characterized by a range of empirical findings. In the second talk, Anna Fiveash will discuss how musical rhythmic priming can be used to enhance processing of the quasi-regular speech signal, and the implications of this research for better understanding connections between rhythmic structures in music and speech. In the third talk, Claire Pelofi will propose a framework for understanding how prediction and learning relate to each other in the context of music processing. In the final talk, Gabriele Cecchetti, Christoph Finkensiep, Xinyi Guan, Steffen Herff, and Martin Rohrmeier will discuss how musical structural processing can be modelled and empirically investigated as a form of syntactic parsing. Overall, the symposium presents novel theoretical approaches and empirical findings that shed light on the cognitive architecture supporting the processing of musical structure in terms of representation, prediction, and learning, as well as on how such understanding may be fostered by looking at domains where similar cognitive faculties may be recruited – such as language.

John E Drury
Modularity and Attention

Electrophysiological data has played an influential role in understanding the relationship between linguistic and musical cognition/perception. Violation responses in event related potential (ERP) studies of linguistic or musical syntactic processing (e.g., left/right anterior negativities; LAN / RAN effects) have been leveraged in interference paradigms, providing data that are typically interpreted as showing overlap or sharing of underlying neurocognitive mechanisms across these domains. However, it turns out that similar kinds of interaction patterns can be demonstrated for cases where disruptions to the linguistic and musical processing streams involve other ERP components, for example the well-known N400 response linked to semantic memory. Further, interactions can also be shown for music processing alongside other kinds of visually presented non-linguistic sequences (e.g., number sequences obeying an arithmetic rule, or visual narrative / panels of comics). I'll suggest that understanding the current empirical landscape requires attending to attention, which we will do against the backdrop of a brief revisiting of Fodorian conceptions of modularity. Thinking through possible architectures will be aided by considering how a given (sub)system being computationally autonomous (or not) relates to the core notions of "module" in Fodor's sense (domain specificity and informational encapsulation).

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Anna Fiveash
Rhythmic Processing in Music and Speech: Evidence from Rhythmic Priming

To effectively comprehend music and speech, both syntactic and rhythmic structures must be considered. Similarities and possible overlap in structural processing have been shown in both domains, allowing for potential cross-domain influences. One avenue for the investigation of shared structural processing is through rhythm, and whether musical rhythmic primes can influence subsequent processing of the quasi-regular speech signal. Rhythmic priming experiments have shown that presenting ∼30s of rhythmic music before naturally spoken sentences can enhance grammaticality judgements for those sentences compared to irregular or non-rhythmic primes, likely based on sustained neural oscillations and shared rhythmic structural processing. However, this research has so far been limited to grammaticality judgements. New evidence for rhythmic priming will be presented, showing that regular rhythmic primes can also enhance sentence repetition performance compared to irregular rhythmic primes, in both typically developing children and children with developmental language disorder. These results will be discussed within the Processing Rhythm in Speech and Music framework (Fiveash, Bedoin, Gordon, & Tillmann, 2021), with implications for enhancing language processing in developmental speech and language disorders, and shared processing of rhythmic structures in the brain.

Claire Pelofi
Principles of learning revealed by musical enculturation

Most humans spontaneously engage with, and enjoy, the music from their own culture, that they have been exposed to on a daily basis throughout their lives. And yet, despite the astonishing diversity in melodic, harmonic, timbral and rhythmic structure across musical cultures, they are also able to process and rapidly learn music they were never exposed to before. Learning –and enjoying– music implies acquiring an implicit knowledge, or an internal model, of the statistical rules governing sequences of musical events (e.g.m sequences of notes, rhythms, timbral variations *etc.*). Reciprocally, the internal model used by listeners to make musical predictions reflect the musical cultures to which they were exposed to. Critically, it determines which musical events they will find unexpected during music listening. Here we present a general framework, based on the predictive coding theory and modeling expectations during musical listening, that accounts for behavioral, computational, and neurophysiological evidence of learning musical sequences.

Cecchetti, Finkensiep, Guan, Herff, Rohrmeier
A generative framework for modelling music processing beyond the computational level

From a music-theoretical perspective, musical structure can be understood as an underlying abstract generative model that has the capacity to "explain" the observed musical events in terms of operations applied to latent entities that are not observed (e.g., an abstract concept like a harmony). Music-theoretical statements about musical structure serve as descriptions at the computational level of a cognitive process – mapping the observed musical surface into some representation or trace of a plausible underlying generative derivation. It has been proposed that aspects of the experience of music may be characterised in terms of cognitive processes implementing such inference as a form of parsing (Jackendoff, 1991). Can this hypothesis be investigated empirically? In psycholinguistics, frameworks such as the Dependency Locality Theory (Gibson, 1998) contribute to turn computational-level generative models into empirically testable hypotheses about the computational, algorithmic, and implementational features of language comprehension. By extending such predictions to the musical case, moment-by-moment estimates of processing complexity associated with parsing rhythmic or harmonic structure can be computed. These were found to carry predictive value towards (1) the perceived temporal location of visual flashes presented during listening to rhythmic stimuli, and (2) theta-band brain activity in MEG data. Overall, these results highlight the usefulness of formalising music-theoretical insights into generative models, by methodological analogy with psycholinguistics.

Organizers and Moderators:
Christoph Finkensiep, Gabriele Cecchetti, Xinyi Guan, and Steffen Herff.

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