UC San Diego

Lecture 9.1 Cognitive Constraints on Music Perception

MUS 20 Exploring the Musical Mind

Summer Session II 2025

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Case Study: Serialism

- Boulez's *Le Marteau sans Maftre* (1954) was widely hailed as a masterpiece of postwar *serialism*. Yet nobody could figure out, much less hear, how the piece was serial.
- From hints in Boulez (1963), Koblyakov (1977) at last determined that it was indeed serial, though in an idiosyncratic way.
- Listeners made what sense they could of the piece in ways unrelated to its construction.
- Comprehension takes place when the perceiver is able to assign a precise mental representation to what is perceived.
- Comprehension requires a degree of ecological fit between the stimulus and the mental capabilities of the perceiver.

Case Study: Serialism

- Experienced listeners do not find *Le Marteau* totally incomprehensible, but neither, I would argue, do they assign to it a detailed mental representation. This is why the details of the piece are hard to learn and why the piece does not in the end feel complex. The serial organization that Koblyakov found is opaque to such structuring.
- A musician of Boulez's calibre would not use a compositional system without drawing crucially upon his musical intuition and experience.
- Music-generating algorithms alone have always produced primitive outputs. He then shaped his material more or less intuitively, using both his "ear" and various unacknowledged constraints. In so doing, he listened much as another listener might.

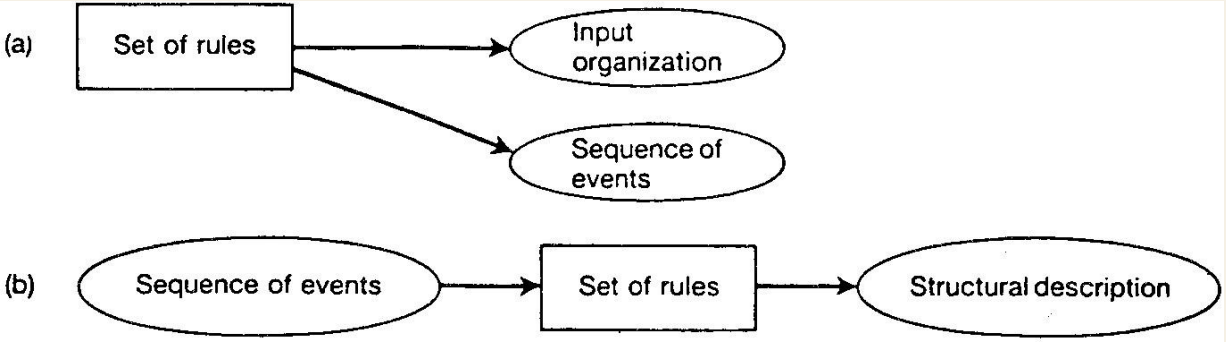
Case Study: Serialism

- The organization deciphered by Koblyakov was just a means, and not the only one, towards an artistic end.
- The degree to which *Le Marteau* is comprehensible, then, depends not on its serial organization but on what the composer added to that organization.
- The serial procedures profoundly influenced the stimulus structure, leading to a situation in which the listener cannot form a detailed mental representation of the music. The result is a piece that sounds partly patterned and partly stochastic.

Compositional and listening grammars

Cognitive Constraints on Compositional Systems by Fred Lerdahl

- Our discussion of *Le Marteau* suggests that there are two kinds of musical grammar at work here.
- The first is the *compositional grammar*, consciously employed by Boulez, that generated both the events of the piece and their serial organization.
- The second kind is the *listening grammar*, more or less unconsciously employed by auditors, that generates mental representations of the music.



Implication-Realisation (IR) theory

The Analysis and Cognition of Basic Melodic Structures (1990); Melodic Complexity (1992)

- The Implication-Realization (I-R) model was developed by *Eugene Narmour* as an alternative to *Schenkerian analysis* which sketched ideas for a new model of analysis based on *musical expectation* and *Gestalt principles* (completion, closure, good continuation, proximity, etc.) as informed by the work of *Leonard Meyer*.
- *Narmour* presents the Implication-Realisation (IR) theory of music cognition which, like GTTM, is intended to be general (although the initial presentation was restricted to melody) but which, in contrast to GTTM's static approach, starts with the dynamic processes involved in perceiving music in time.

Implication-Realisation (IR) theory

The Implication-Realization Model (I-R)

- The theory posits two distinct perceptual systems (sources of implication and realization):
  - The bottom-up (BU) system: hard-wired, innate and universal; mechanistic, automatic, and largely implicit; defines function (*closure vs. non-closure*)
  - The top-down (TD) system: learnt through musical experience; stylistically flexible, cognitively learned, and stylistically explicit; tracks form (*similarity vs. differentiation*)

This makes possible interactions between two different types of implications. The two-systems may conflict and, in any given situation, one may override the implications generated by the other.

Implication-Realisation (IR) theory

The Implication-Realization Model (I-R): Quotation, *Eugene Narmour (2014)*

- The I-R model hypothesizes that post-sensory signals are encoded in a primary BU (bottom-up) system, which extracts events according to separate parameters (pitch sets, contours, consonances and dissonances, timbres, durations, meters, etc.).
- Secondary BU processing then operates on these primitives according to *Gestalt principles*, creating coherent implications and realizations for higher-level syntactic analysis.
- From this parsing, primary TD (top-down) processing subsequently identifies modes, scale-step functions, chord types, metric hierarchies and other such pre-primed information.

Implication-Realisation (IR) theory

The Implication-Realization Model (I-R): Quotation, *Eugene Narmour (2014)*

- The TD system likewise activates a secondary level that relies on mapping previously learned, hierarchically complex, time-ordered schematic expectations (voice leading, harmonic processes, tonal strategies, formal constancies, etc.).
- In short, the BU system is essentially a servo-mechanism that enables the TD system to access stylistic norms of implications and realizations, whether conditioned, habituated, or associated.
- Fed back to the BU system, TD levels of complexity channel our attention to implicative input that deviates from explicit mapping. When the auditory world is as we expect it, the BU system runs unconsciously in the background.

Implication-Realisation (IR) theory

The Implication-Realization Model (I-R): Quotation, *Eugene Narmour (2014)*

- Bi-focal operations such as this minimize implicative error.
- Feedforward causes the higher-level system to hunt continuously for conformance in order to invoke the most statistically relevant schemata, while feedback frees up lower-level systems to abstract novel or nuanced auditory information.
- Neither system overrides the other since novelty must always be learned, updated, and transformed into higher-level memory. Likewise, TD schemata must remain attuned to redundant input, which statistically codifies or rejuvenates old memory in order to anticipate complexities apt to recur in upcoming contexts.
- Significant mismatches between what was implied vis-à-vis what was realized produce felt arousal and tension (i.e., moods, affects, emotions)

Implication-Realisation (IR) theory

Computational Modelling of Music Cognition and Musical Creativity, Pg.5

- In the bottom-up system, sequences of melodic intervals vary in the degree of *closure* that they convey.
- Strong closure signifies the termination of ongoing melodic structure.
- An interval which is unclosed is said to be an *implicative interval* and generates expectations for the following interval, termed the *realised interval*.
- The expectations generated by implicative intervals for realised intervals are described by Narmour (1990) in terms of several principles of continuation which are influenced by the *Gestalt principles* of proximity, similarity, and good continuation.

Implication-Realisation (IR) theory

Computational Modelling of Music Cognition and Musical Creativity, Pg.5

- The IR model also specifies how the basic melodic structures combine together to form longer and more complex structural patterns of melodic implication within the IR theory. In particular, structures associated with weak closure may be chained to subsequent structures. In addition, structural tones (those beginning or ending a melodic structure, combination or chain) which are emphasised by strong closure at one level are said to transform to the higher level.