Proposed Course on Music Perception and Cognition

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Music/Computing (Not) Away Day

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1. Goals and outcomes

- Goal is to provide a solid grounding in the field of music perception and cognition.
- Introduce students to experimental, theoretical and computational work that has significantly contributed to our understanding of the psychological processes underlying musical behaviour.
- By the end of the course, the students should have a firm understanding of the most important, foundational experimental and theoretical work in music perception and cognition.
- Students will be prepared for carrying out further work in the field.
- Course will provide knowledge and insights that can be applied to other fields of musical activity
- Also introduce students to sound scientific methodologies and techniques.

2. Overview

- Devote approximately two hours of lecture time to each of the following topics:
  - Perception of metrical structure
  - Perception of grouping structure
  - Auditory stream segregation in music
  - Cognition of pitch in tonal, atonal and non-Western music
- Could also give two-hour lectures on
  - Sound waves and the peripheral auditory system
  - Music and the central auditory system

3. Perception of metrical structure

- Informal tapping experiment: students asked to tap (secretly) at various speeds in time to a simple melody.
  - Introduces idea that metrical structure is hierarchical.
  - Students usually tap at different rates that are related by integer multiples—illustrates that psychological theories have to be able to account for variation in behaviour as well as regularity.
  - Ask them to describe how they decide when to tap: usually can't do it—illustrates problems of relying on introspective judgements.
- Lerdahl and Jackendoff's (1983) theory of metrical structure—strongly influenced later work.
- Povel and Essens's (1985) experimental work and 'clock induction' theory of metre perception.
- Lee's (1991) work in which he analyses certain key assumptions in early models of metre perception, in particular:
  - long notes and strong beats;
  - avoiding syncopation;
  - effect of repeated patterns; and
  - processing considerations.
- Finish with Temperley's (2001) computational model of metre perception which is heavily based on that of Lerdahl and Jackendoff.

4. Perception of grouping structure

- Define grouping structure and develop concept using theme from Mozart's G minor symphony.
- Again begin with Lerdahl and Jackendoff's (1983) theory of grouping structure:
  - talk about how different components of theory are interrelated in a way that it makes it difficult (but not impossible) to implement as a computer program;
  - talk about relationship between Gestalt principles and grouping which suggests that principles underlying musical grouping are ones that govern auditory perception in general.
- Discuss Deliège's (1987) experimental work in which she tested some of the claims of Lerdahl and Jackendoff's grouping theory;
- Briefly discuss Cambouropoulos's (1998) Local Boundary Detection Model and Temperley's (2001) computational model of phrasing as examples of recent computational models of metrical structure perception.

5. Auditory Stream Segregation (Sequential Integration)

- The connection of parts of an auditory spectrum over time to form concurrent streams.
- Example is connection of consecutive tones played on a single instrument to form a single percept which we call a melody.
- Explain that both grouping and streaming seem to be partially explicable in terms of the Gestalt principles and the grouping is actually the segmentation of streams into structural units.
- Stress the massive amount of processing that the brain has to do automatically in order to analyse the unstructured sound signal and determine how it was constructed from sounds from various sources.
- Then base most of the rest of the lecture on Bregman and Ahad's (1995) excellent CD of auditory demonstrations illustrating the principles of stream segregation proposed by Bregman (1990).
- For example, talk about
  - effect of frequency separation and tempo on stream segregation
  - difficulty of perceiving temporal relationships between elements in different streams;
  - difficulty of perceiving patterns that contain events in more than one stream;
  - examples of stream segregation in Bach and in African amadinda music
  - streaming based on timbre differences
- Computational theories of the perception of voice structure in Western music proposed by Temperley (2001) and Chew and Wu (2004).

6. Cognition of Pitch Structure

- Based on Krumhansl's (1990) *Cognitive Foundations of Musical Pitch*.
- Focus primarily on experimental work that reveals perceived relationships between tones, chords and keys in Western tonal music.
- Explain
  - probe-tone experimental paradigm
  - Likert scales
  - Shepard tones
- Stress importance of effect of musical training on perception of tonal relationships.
- Talk about using the results of Krumhansl and Kessler's (1982) to derive multidimensional scaling model of the perceptual distance between keys in tonal music.
- Difference between tonal and musical consonance.
- Correlation of tonal hierarchies with statistical distributions of tones in tonal works.
- Krumhansl and Schmuckler's key-finding algorithm.
- Perception of key in polytonal music (Krumhansl and Schmuckler, 1986).
- Tonal hierarchies in serial atonal music (Krumhansl, Sandell, and Sergeant, 1987).
- Tonal hierarchies in North Indian Music (Castellano, Bharucha, and Krumhansl, 1984)

References

Bregman, A. S. and Ahad, P. A. (1995). Demonstrations of auditory scene analysis: The perceptual organization of sound. Audio CD.

Bregman, A. S. (1990). *Auditory Scene Analysis: The Perceptual Organization of Sound*. MIT Press, Cambridge, MA.

Cambouropoulos, E. (1998). *Towards a General Computational Theory of Musical Structure*. Ph.D. thesis, University of Edinburgh.

Castellano, M. A., Bharucha, J. J., and Krumhansl, C. L. (1984). Tonal hierarchies in the music of North India. *Journal of Experimental Psychology: General*, **113**, 394–412.

Chew, E. and Wu, X. (2004). Separating voices in polyphonic music: A contig mapping approach. In *Second International Symposium on Computer Music Modeling and Retrieval (CMMR 2004) (May 26–29, 2004)*, Aalborg University Esbjerg, Esbjerg, Denmark.

Deliège, I. (1987). Grouping conditions in listening to music: An approach to Lerdahl and Jackendoff's Grouping Preference Rules. *Music Perception*, **4**(4), 325–360.

Krumhansl, C. L. and Kessler, E. J. (1982). Tracing the dynamic changes in perceived tonal organisation in a spatial representation of musical keys. *Psychological Review*, **89**, 334–368.

Krumhansl, C. L. and Schmuckler, M. A. (1986). The *petroushka* chord: A perceptual investigation. *Music Perception*, **4**(2), 153–184.

Krumhansl, C. L., Sandell, G. J., and Sergeant, D. C. (1987). The perception of tone hierarchies and mirror forms in twelve-tone serial music. *Music Perception*, **5**(1), 31–78.

Krumhansl, C. L. (1990). *Cognitive Foundations of Musical Pitch*, volume 17 of *Oxford Psychology Series*. Oxford University Press, New York and Oxford.

Lee, C. S. (1991). The perception of metrical structure: Experimental evidence and a model. In P. Howell, R. West, and I. Cross, editors, *Representing Musical Structure*, pages 59–127. Academic Press, London.

Lerdahl, F. and Jackendoff, R. (1983). *A Generative Theory of Tonal Music*. MIT Press, Cambridge, MA.

Povel, D.-J. and Essens, P. (1985). Perception of temporal patterns. *Music Perception*, **2**, 411–440.

Temperley, D. (2001). *The Cognition of Basic Musical Structures*. MIT Press, Cambridge, MA.