

EUROPEAN
SOCIETY FOR THE
COGNITIVE SCIENCES
OF
MUSIC

This volume collects together all the contributions that were delivered in the form of papers or in special sessions during the Conference. It will be made available at the opening of the Meeting in order to enable participants to acquaint themselves with the outlines of each session prior to attending.

The organisation of the table of contents follows that of the programme schedule. The first part comprises the Keynote Addresses. The second is devoted to the contents of four Symposia. The third (and last) section covers the seventeen Thematic Sessions.

The Conference brings together a large number of well-known figures in the field and researchers - from more than twenty different countries - working on a very wide range of aspects of science and music. They have responded with near-unanimity to the request of the Scientific Committee to send-in their texts in advance of the Conference for this publication. That this volume has appeared is thanks to them, and it is hoped that it will contribute to the success of the event.

All publications of the European Society for the Cognitive Sciences of Music (ESCOM) will henceforth appear with ISBN and copyright inscription. This volume is the first to benefit from this state of affairs.

*Troisième Conférence Internationale pour
la Perception et la Cognition Musicales (3e ICMPC)*

Avant-Propos

Cet ouvrage reprend l'ensemble des contributions qui feront l'objet des présentations de la conférence dès l'ouverture de la manifestation afin de permettre une rapide prise de contact avec les contenus avant les séances.

UNIVERSITE DE LIEGE

23-27 July - Juillet 1994

L'organisation de la table des matières suit le déroulement du programme. La première partie reprend les Conférences. La seconde est consacrée aux quatre symposiums. La troisième et dernière partie, enfin, couvre les dix-sept sessions thématiques.

3rd - 3^e I C M P C

La conférence réunit un large ensemble de personnalités de renom et de chercheurs de plus de vingt pays différents, travaillant dans des domaines très divers en matière de science et de musique. Ils ont répondu avec une quasi-unanimité à la demande du Comité Scientifique de leur adresser leurs textes en avance de la conférence. C'est grâce à eux que ce volume a pu paraître et qu'il contribue ainsi au succès de l'événement.

**International Conference for Music Perception and Cognition
Conférence Internationale pour la Perception et la Cognition musicales**

PROCEEDINGS - ACTES

Irène Deliège, editor

Toutes les publications de la Société Européenne des Sciences Cognitives de la Musique (ESCOM) paraîtront désormais avec la numérotation internationale du Livre et dépôt légal. Ce volume est le premier à bénéficier de cette disposition nouvelle.

Big sister Pitch's little brother Timbre comes of age

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The study of pitch perception and the processing of pitch structures and systems has largely dominated music psychology throughout its history. Other form-bearing auditory "dimensions" such as rhythm and timbre have been given only secondary and tertiary importance, respectively (McAdams, 1989). Timbre, that (until recently) ill-defined younger sibling of Pitch and Rhythm, has nonetheless increasingly captured the imaginations of composers, theorists, and scientists alike. What I will attempt in this brief presentation is to give a global view of some of the main directions the experimental and theoretical research is taking at present, as well as a few suggestions for important problems to address in the near future.

Among the main areas where research on timbre as a potential structuring force in music are making progress, I will discuss the study of auditory organisation processes (of which timbre, like all other auditory attributes, is a by-product), multidimensional analyses of the perceptual dimensions underlying timbre and their acoustic correlates, and the study of the perception of abstract relations among timbres. Other areas that are of interest, but which space does not allow me to discuss, include the recognition and memory of the timbre of sound sources and of sequences of timbres, as well as the perceptual interactions between pitch structures and timbral structures in music.

Auditory organization

Research on auditory organization processes has demonstrated that timbre is an auditory attribute resulting from the perceptual grouping of concurrent acoustic components (Bregman & Pinker, 1978). Therefore compositional control of the cues affecting grouping is an important consideration in the creation of timbral objects in sound synthesis and orchestration. Striking examples of

this include the maximization of fusion cues such as parallel frequency motion, onset asynchrony and harmonicity in the composition of *Boléro* by Ravel. Capitalizing on the cues for fusion in the compositional structure allows the composer to use the orchestra as a kind of synthesis instrument with which he can build up a composite timbre with several instruments. Later in this century the "spectral school" of French composers continued in this tradition.

An important theoretical ground for explaining how auditory organization processes play a role in the control of dissonance have been laid by Wright & Bregman (1987). They propose a framework to explain how the perception of a timbral property such as roughness, which is one of the primary sensory components of musical dissonance, depends on the way simultaneously present sound events are organized by the perceptual system. If two overlapping events (that might otherwise create a dissonant harmonic interval when presented synchronously and in relative isolation) can be interpreted as belonging to independent sequential auditory streams, then their degree of perceived dissonance is lessened. It remains for these ideas to be tested experimentally (though see Bigand *et al.*, this conference, for a beginning approach), but if they can be supported by experimental data, the implications for compositional practice and orchestration are far-reaching.

Some of the acoustic dimensions underlying timbre are important factors in the organization of the musical surface into melodic streams and segments, indicating that compositional control of timbre can also be a structuring force at this level (Deliège, 1987).

Multidimensional analysis

The timbre of a perceptually fused event has been shown to have a multidimensional character (Plomp, 1970; Miller & Carterette, 1975; Grey, 1977). This multidimensional analysis has even been extended to timbral blends (Kendall & Carterette, 1991). Current research in several laboratories has allowed us to define the acoustic dimensions and auditory processes that result in this complex perceptual representation (cf. Krimphoff *et al.*, 1994). This work may well provide the basis for the development of perceptually relevant control of sound synthesis or of computer-assisted orchestration algorithms. Multidimensional representations have also been shown to be sensitive to context effects only for certain kinds of timbral variation (see Donnadieu *et al.*, this conference) and future work

should be oriented toward understanding the importance of musical context on the perception of musical relations among timbres.

Perception of timbral relations

Recent work further suggests that relations among timbres may be perceived in their own right, giving rise to the possibility for composition of timbral melodies that can be recognized under various kinds of transformation such as transposition. Timbral intervals can thus be defined with respect to the relative positions of timbral objects in a multidimensional space that captures the mental representation of a set of timbres within a given context (McAdams & Cunibile, 1992). These early results were encouraging but need to be extended under more controlled conditions to verify the notion that listeners are truly capable of extracting and comparing relations between timbres as opposed to comparing the timbres themselves.

A number of limitations to this fine-grained structural use of timbre in ways analogous to pitch need to be pointed out. These have to do with the very close relation that timbre holds to the inference of the physical cause of a sound event, linking it inexorably to identification and thus to an absolute perception of the source rather than to the structural relation of the event it has produced to surrounding events. What melodic perception, and the very notion of transformation of musical materials, presume is a perception of abstract relations between the perceptual attributes of a sequence of sound events. If we tend to perceive timbre in a more absolute way, it may be difficult to use it in situations where perception of a musical development depends on the abstraction of relations. That timbre is perceived more absolutely in sequences than is pitch is suggested by the work of Krumhansl & Iverson (1992) which has shown that detection of change in the pitch of a note in a melody is affected by the stability of the surrounding pitch intervals while detection of change in a note's timbre is unaffected by such changes in the surrounding timbres.

Of course, one cannot rule out the possibility that this perceptual tendency is the result of acculturation. Given that the structures present in the music of most cultures do not appear to employ invariant transformations of timbral relations, as occurs with pitch configurations, it may be that children never learn to extract such relations quite simply by lack of exposure to them. It would be very interesting to do long-term developmental studies on the

acquisition of these kinds of abilities. But that would imply the existence of an educational infrastructure that seems rather utopic given today's cultural context.

References

- Bregman, A. S. & Pinker, S. (1978). Auditory streaming and the building of timbre. *Canadian Journal of Psychology*, **32**, 19-31.
- Deliège, I. (1987). Grouping conditions in listening to music: An approach to Lerdahl et Jackendoff's grouping preference rules. *Music Perception*, **4**, 325-60.
- Grey, J. M. (1977). Multidimensional perceptual scaling of musical timbres. *Journal of the Acoustical Society of America*, **61**, 1270-7.
- Kendall, R. A. & Carterette, E. C. (1991). Perceptual scaling of simultaneous wind instrument timbres. *Music Perception*, **8**, 369-404.
- Krimphoff, J, McAdams, S. & Winsberg, S. (1994). Caractérisation du timbre des sons complexes. II: Analyses acoustiques et quantification psychophysique. *Proceedings of the 3rd French Congress of Acoustics, Toulouse* (in press).
- Krumhansl, C. L. & Iverson, P. (1992). Perceptual interactions between musical pitch and timbre. *Journal of Experimental Psychology: Human Perception and Performance*, **18**.
- McAdams, S. (1989). Psychological constraints on form-bearing dimensions in music. *Contemporary Music Review*, **4**(1), 181-198.
- McAdams, S. & Cunibile, J-C. (1992) Perception of timbral analogies. *Philosophical Transactions of the Royal Society, London, Series B*, **336**, 383-389.
- Miller, J. R. et Carterette, E. C. (1975). Perceptual space for musical structures. *Journal of the Acoustical Society of America*, **58**, 711-20.
- Plomp, R. (1970). Timbre as a multidimensional attribute of complex tones. In *Frequency analysis and periodicity detection in hearing* (eds. R. Plomp et G. F. Smoorenburg), pp. 397-414. Sijthoff, Leiden.
- Wright, J. K. & Bregman, A. S. (1987). Auditory stream segregation and the control of dissonance in polyphonic music. *Contemporary Music Review*, **2**(1), 63-92.