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Is Pleasantness for Soundscapes Dimensional or Categorical?

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Summary: This paper focuses on the dimensional or categorical characteristics of pleasantness for soundscapes. 16 sequences of urban soundscapes were recorded, reproduced at their real sound intensity and tested on subjects. Three procedures were used to investigate the mental representations of soundscapes: free categorization, binary choices and ratings. The data were processed through an additive tree algorithm and suggested that the dimensional aspect of pleasantness is rather an artefact of experimental procedures than an intrinsic property of soundscapes.

INTRODUCTION

The amelioration of sound quality of urban environment is generally thought as "making a quieter world", that is reduced to intensity evaluation. Nevertheless, since several years, social actors stressed that soundscape quality cannot be simply reduced to well known and easily recordable acoustical parameters. Indeed, the qualitative appreciation is a cognitive judgment given by listeners and therefore psychological theories and methods have to be taken into account to get at a better understanding of sound quality.

The present work aims at studying pleasantness for urban soundscapes, by evaluating whether the semantics of soundscapes - and more specifically pleasantness - map onto dimensional evaluations of physical parameters. In other words, we investigate whether pleasantness, as one characteristic of cognitive representations of soundscapes, is dimensional or categorical.

METHODOLOGY

Urban soundscapes were recorded through electrostatic microphones (Schoeps, cardioid, 60 cm spacing, 110° spread) and a portable R-DAT, sampled at 48 kHz. A corpus of 16 sound sequences included both sequences in which discriminable sound events (event sequences) could be identified and sequences without any specific sound events (amorphous sequences) [5]. The sequences were reproduced with their real sound intensity, on loudspeakers (Studer A723) in a fairly anechoic surrounding. Subjects were placed at an average distance of 1.5 m from the loudspeakers. The recording and reproduction techniques have been validated previously in order to produce the illusion of real environment [6].

The stimuli were processed along three procedures: one free categorization and two pair comparisons, either binary choices or ratings. In the free categorization task [2,4], subjects were required to group sound sequences into as many categories as they wanted, according to pleasantness similarity. After the sorting task has been completed, subjects were asked to verbally qualify the categories they had formed. 28 subjects took part in the test. In the binary choice method, subjects had to decide which sequence of each pair was the most pleasant for them. In the rating task, they had to rate the pleasantness dissimilarity between the two sequences on a 9 point scale (1: very similar ; 9: very dissimilar). 39 subjects took part in the pair comparison tests.

Subjects could listen the sound sequences as many times as they wanted. The test was run on a PC Pentium 200 equipped with a Digidesign Audiomedia III card. The sequence durations were approximately 15 seconds. Each test session duration lasted an average of 45 minutes.

ANALYSIS AND RESULTS

Analysis: In order to evaluate the variations between results issued from the different methods, all the data were compiled into a similarity matrix and processed through an additive tree algorithm that represent similarity distances [1].

Binary choices give two types of information. The most common is the absolute aspect of the data, that is the preference rate of one sequence compared with the 15 other sequences as a whole. The data of binary choices can also be analyzed from a differential point of view, that is the difference between preference rates. Indeed, such a differential analysis doesn't allow to know which sequence in a pair is preferred but if it is distinctly preferred to the other one. A sequence clearly preferred to an other one involves a large dissimilarity between the two sequences and conversely.

In the figure 1 presented below, numbers in squares represent event sequences and numbers in circles represent amorphous sequences.

Results: From the categorization procedure, data analyses reveal longest distances between two main categories formed around the nodes L_{12} et J_{10}. L_{12} groups event sequences and contrasts with J_{10} which groups amorphous sequences. A linguistic analysis of the verbal data shows that each subcategory of items aggregates different and heterogeneous properties of soundscapes: physical properties (intensity, frequency) and semantic properties as well (effect on subject, nature and quality of the source, proximity of the subject to the source). Unpleasantness for soundscapes seems to be more adequately represented by different categories of sounds rather than continuous variations on a scale.

From the binary choice procedure, the same algorithm of data processing results in a more linear representation, in other words, it leads to give a linear organization between categories. However, some previously observed categories remain along the same distinction: the node F_6 groups event sequences and the node M_{13} amorphous sequences.

The rating tree is the most linear of the three trees. Such a result questions whether or not it is the presupposition of dimensionality of the task itself that imposes a dimensional representation onto the subjects' processing. Nevertheless, once more, event sequences are grouped at the node I_9 and contrasted to amorphous sequences groupes at the node J_{10}.

Globally, it appears that event sequences and amorphous sequences remain well distinguished whatever the method (categories *vs.* ratings *vs.* binary choices) used.

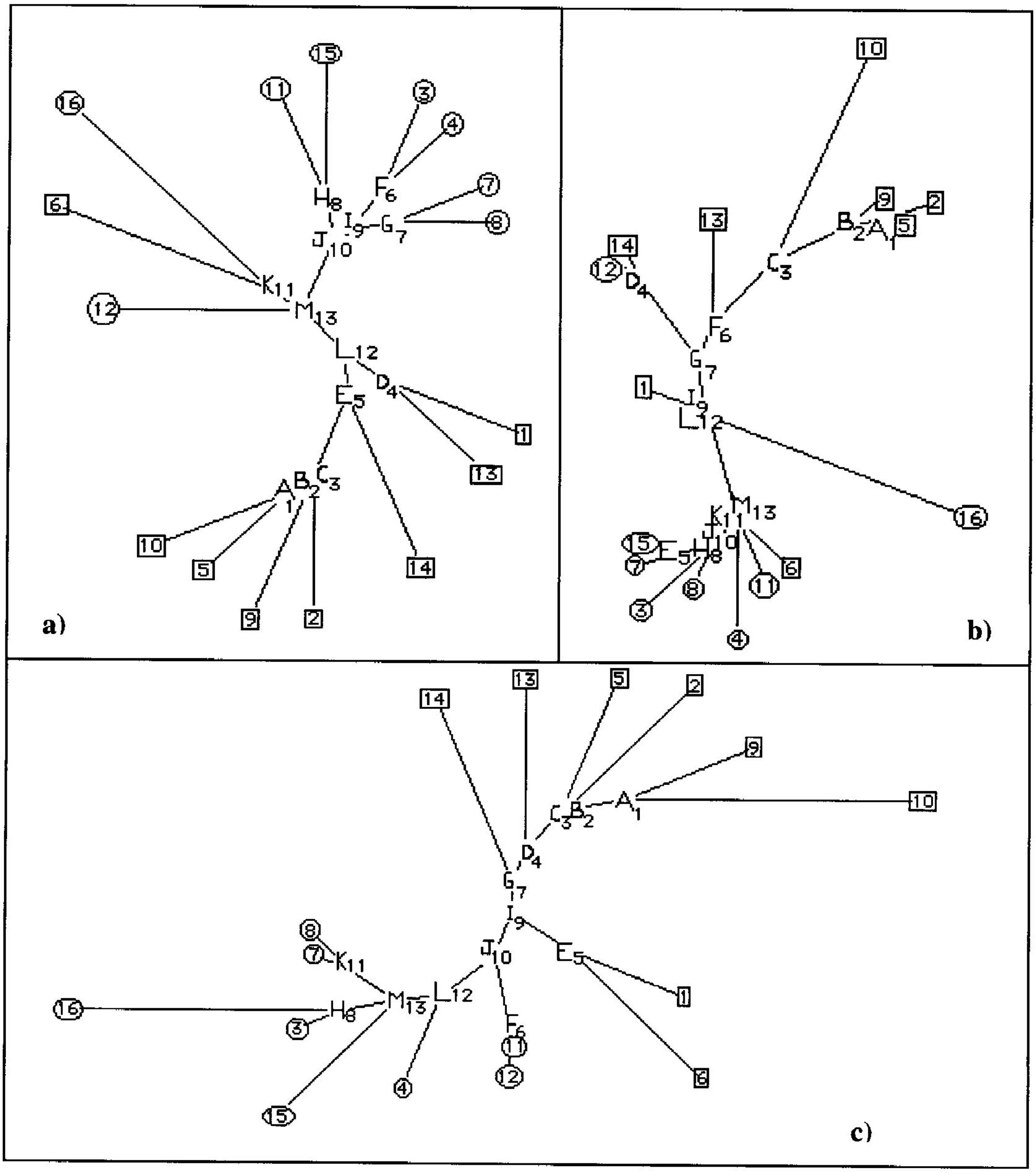

FIGURE 1. Trees from Categorization (a), Binary Choices (b) and Ratings (c) according to Pleasantness.

DISCUSSION AND PERSPECTIVES

Is pleasantness for soundscapes dimensional or categorical? From a cognitive point of view, the classical techniques used in psychoacoustics don't allow us to decide, because of the constraints onto subjects' processing as well as onto data processing and these constraints cannot give but dimensionality of pleasantness. Rating tasks involve judgments, that may be n-dimensional, but projected on one dimension, reducing in this way the information about pleasantness. Binary choice task presupposes nothing as for the dimensionality of pleasantness, that is to say, there is no unidimensional constraint on the polarity, but the pair comparison induced by the question "which is the most pleasant?" prevents from dealing with unpleasantness. The less constrained comparative judgment remains the free sorting task, that allows the subject to structure along a diversity of heterogeneous criteria as revealed by the verbal comments.

Nevertheless, whatever the procedure used, data are robust and consistent, in contrasting event *vs.* amorphous sequences with subcategories within each of these two main categories. Pleasantness does not appear as conceptually abstracted as an autonomous dimension across the set of stimuli but rather as categorical. Indeed, the diverse categories of pleasantness (or unpleasantness) aggregate other characteristics of soundscapes such as the presence or absence of events, and within these categories diverse qualities of the sounds. This heterogeneous categorical space thus supports the hypothesis that pleasantness is not dimensional.

On a methodological ground, such data question both procedures and data processing that presupposes dimensionality and particularly the inferences made from data processing relying on euclidean metrics. Indeed, the additive tree algorithm used as analysis of the data does not assume an euclidean metric, contrary to the classical analysis used in psychoacoustics (multidimensional scaling for example) that take linearity of indicators for granted. The distribution along an a priori dimensional representation actually corresponds to the mapping of different aggregates of heterogeneous categories of sounds. It seems to be theoretically misleading to project dimensionality onto a semantic phenomenon such as pleasantness.

In the rational of our research, a more precise psycholinguistic analysis of the verbal comments [3] would be fruitful in order to get at the conceptual representation of pleasantness. A pilot analysis showed that the presence of events giving sense of life make soundscapes more pleasant. But if subjects identify traffic noises, they are interpreted, whatever the sound level is, as unpleasant sounds. Globally, the pleasant/unpleasant characteristics of a sequence or a set of sequences is correlated to the identified sources within the sequences. Such an experiment combining linguistic and psychological analyses shows that urban soundscapes include a complex combination of unpleasant and pleasant noises. Finally, it appears that subjects' cognitive representation influences their perception ; people cannot judge a sound phenomenon independently of the signification they attribute to it.

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