A cognitive approach to sounscape
Acoustic phenomena between **"noise(s)"** and "**sound(s)**"

Danièle Dubois, Catherine Guastavino, Valérie Maffiolo

CNRS/LCPE/LAM, 11 rue Lourmel 75015 Paris ddubois@ccr.jussieu.fr

Introduction

The notion of soundscape was introduced by Schafer (1969) as an auditory equivalent to landscape. It is defined as a sonic environment but, it explicitly includes a subjective component, the way the environment is perceived and understood by the individual, or by a community. As such, urban soundscapes have recently changed a great deal in our societies, with the development of transportation and the generalised use of motors, engines, and more generally mechanical devices.

Furthermore, the increasing problem of noise annoyance has revealed the limits of physical descriptions to account for the subjective impression of acoustic phenomena and the concept of *soundscape* can be therefore thought of as an alternative approach to quantitative approaches (Lercher & Schulte-Forkampf, 2003; Schulte-Forkampf 2002). As attempts to define "global" indicators of noise annoyance by adding the contribution of different acoustic parameters, left aside the semantic value attributed to sounds, the concept of soundscape requires a more global approach to urban environments and suggests a more cognitive approach to noises that as **meaningful** events. This paper aims at presenting evidence that the subjective effects of complex sounds generally encountered in cities actually rely more on their semantic values than on acoustic parameters, and to figure out how the physical world **affects** people and how they elaborate a **representation** of it from their experience.

We describe here some results of such a program carried out within French institutions[1] as a collaborative project between acousticians, engineers, psychologists and linguists. The research focuses on how people give meaning to urban soundscapes from their everyday experience (psychology), and how individual assessments are conveyed as collective expressions through language (linguistics).

Categorization of soundscapes

1. A first set of soundscapes were selected from a list of locations identified as representative of city noises (Paris) (more precisely described in Maffiolo, 1999; Vogel, 1999; Maffiolo & al., 1998). 16 sequences were used, each lasting from 15 to 20 seconds. 23 subjects participated in a **free sorting task.** The results show that recordings are not clustered along an intensity dimension **alone**: not only the notion of average intensity for such complex acoustic stimuli is problematic, even from a physical point of view, but subjects cluster sequences of different mean intensities (sequence 9 (68,9 dBA) with sequence 10 (75,3 dBA), for example): at a generic level, two main cognitive categories of sequences emerge:

- (a) *"event sequences"* i.e. sequences including specific events ('starting a car', 'breaking', 'giving a speech' ...),
- (b) "*amorphous sequences*", such as 'background noises' in which no specific event could be isolated.

Linguistic analysis of verbal descriptions and comments of the subjects' categories suggests that soundscapes are structured into complex semantic categories integrating not only acoustic parameters or properties but also notions of time, location and activities. These notions are reflected in discourse by complex prepositional phrases with multiple complements such as "*riding motorcycles at Bastille on Saturday night"*.

2. These distinctions between categories of soundscapes were further explored for **low frequency environmental soundscapes** with a more precise psycholinguistic analysis of free descriptions of urban environments and free sorting tasks as well (Guastavino, 2003; by Guastavino and Cheminée, 2003, Guastavino (submitted)). Two broad categories were here infered from the linguistic analysis:

- *source events*, which can be attributed to an identified source and agent, and
- *background noise of the city*, considered as collective noise, where no specific events can be discriminated.

As the category name implies, *source events* tended to be linguistically described with reference to specific sources, by nouns referring to the object (*truck, bus*) or part of the object (*engine, muffler*) generating the **noise**. These metonymies indicate a non-distinction between the sound and the source producing the noise, and suggest that the acoustic phenomena is not abstracted from the object generating the sound. The *background noise* was on the contrary described primarily in terms of physical properties suggesting a more abstracted conceptualization of the *background noise* as a **sound** object in itself.

From the free sorting experiments carried out on 16 amorphous sequences, two main categories emerged on the basis of absence or presence of human activity, in relation to perceived pleasantness. The human activity category was spontaneously described as **pleasant**, whereas the **traffic noise** category was described as **unpleasant**

A finer grain categorisation distinguishes subcategories within each of these two categories. Half of the subjects subcategorised ***traffic sequences*** on the basis of the presence of human sounds in relation to the judgements of pleasantness : just "**unbearable**" in the absence of human sounds vs. "only" "**unpleasant**" when a few human sounds can be heard (23% of the subjects elaborated subcategories according to the type of vehicles ("bus", "heavy vehicles").

Meanwhile, ***human activity sequences*** were subcategorised by 75% of the subjects on the basis of the type of activities

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performed *("do the groceries", "have a drink", "take a walk"),* ranging on second dimension related to the degree of tranquillity (from "*busy*" open markets to "*quiet*" parks). The activity sequences were described mostly by nouns referring to the type of locations ("*market*", "*café*" or "*restaurant*", "*park*") and identified sound sources *("vendors", "music", "birds").* Furthermore spatial attributes played an important role at this subordinate level, although all recordings were carried out in outdoors environments. One third of the subjects used urban morphology criteria to distinguished reverberating spaces (described as *"reverberating", "semi-closed", "hall", "shopping mall")* and open spaces *("open", "large squares", "outdoors")* within the human activity category (see also Raimbault, 2002, on this point).

In short, it can state that *source events* are perceived as psychological effects caused by objects of the world that is, as **noise** as a relation of the subject to the world (and not as an autonomous stimulation "standing outside in the world"). For *background noise*, on the contrary, few references are made to the object source and we got a majority of simple adjective referring to the physical properties of the acoustic signal in itself (temporal structure and timbre) suggesting a more abstracted conceptualization of the *background noise* as a **sound** as a more objective phenomenon.

Summary and conclusion : Soundscapes as cognitive categories

To summarize, two main results can be drawn from free categorisation tasks (psychological analysis) associated with the (linguistic) analysis of verbal comments :

- First, the noises under investigation can hardly be reduced to a set of expected physical parameters. In particular, intensity (or even loudness) is **not** the only nor the most important criterion involved in noise categorisation. Such a conclusion is in agreement with results obtained by engineers involved in ecology and noise reduction as well as by acousticians of the scientific community (Guski, 1999). Intensity (as a cognitive representation) is more a **property** within a categorical structure than a **dimension,** which variations are not psychologically monotonous when correlated to semantic features, such as hedonic characteristics, identification of the source, or meaning of the event (warning...).
- Second, the stimuli can be processed either as **part of a meaningful event** or, in a more analytic manner, along **physical parameters.** As part of an event, they are processed as **noise**s and may therefore be considered as **effects** of the world on the subject (as is the case for odours, see Dubois, 2000). **It is only when** the process of source identification fails that the stimuli are processed as abstract **sounds**, (such as colours are processed), and which can be then characterised along as "dimensions" described by physical science.

Therefore, to sum up, in comparison to physical (i.e. physically described) concepts, a cognitive representation of acoustic phenomena is characterised by the following properties:

- *It isan **individual**, **non-observable** subject-centred representation*
- *It i**s global** and **multimodal (**auditory, and kinaesthetic, vestibular, …as well),*
- *Always experienced in **context** and in practices; therefore may not be unique*
- *"made of" **memory**: it includes perceptions **and responses** given to "inputs": it is both individual (sensory experience) and **collective** (as everyone is a member of a community),*
- *It involves **interpretations** (meaning production and not simply "pre-existing information processing")*
- *It is connected to, constructed by **linguistic** expressions and therefore to meaning conveyed in languages and thus it is **shared and can be accessed** through verbal and symbolic **public representations**.*

Research on soudscapes should therefore integrates the collaboration of physical science and engineers competence associated to human sciences, such as psychology, linguistics and sociology.

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