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Perceptual study of soundscapes in train stations

Julien Tardieu [a,b,*], Patrick Susini [a], Franck Poisson [b], Pauline Lazareff [b], Stephen McAdams [a,c]

[a] *SMTS-IRCAM-CNRS, 1 Place Igor Stravinsky, 75004 Paris, France*

[b] *SNCF – Direction de l'Innovation et de la Recherche, 45 rue de Londres, 75008 Paris, France*

[c] *CIRMMT, Schulich School of Music, McGill University, 555 Sherbrooke Street West, Montreal, Québec, Canada H3A 1E3*

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Abstract

This paper presents a study on the perception of soundscapes in train stations. The two issues addressed by this study are (1) to show that people's knowledge about the space typology that makes up a train station is also based on sound information, and (2) to show that this information is involved in the recognition of the type of space. This study is composed of two stages. In the first stage, two auditory experiments are performed on 66 soundscape samples recorded under natural conditions: (1) free categorization with verbalization and (2) forced-choice recognition. The statistical and lexical analysis of the first experiment reveals three main types of acoustical information: sound sources, human activities, and room effects. The results of the second experiment show that people were able to recognize the type of space (platform, hall, etc.) just by listening to its soundscape. Comparison between Experiments 1 and 2 reveals the auditory similarities of the soundscapes that were recognized as belonging to the same category. In the second step, an *in situ* questionnaire survey was carried out and confirms the laboratory results. Indeed, when travelers are asked to describe the soundscape of the space in which they are situated, they use the same kind of auditory similarities as those found in the experiments.

Keywords: Soundscape; Public spaces; Train stations; Auditory perception; Categorization; Space typology

1. Introduction

The sounds of everyday life convey information about the objects around us. Several studies have shown that listeners are able to recognize the properties of an object just by listening to how it sounds [1,2]. This means that the sound of an object contains acoustical cues that are interpreted by the listener in order to recognize the source or its properties. These questions are studied through the fields of psychoacoustics and auditory cognition [3]. In the field of psychology, many authors agree that our knowledge of the world that surrounds us is organized into categories of objects that are linked in terms of semantic similarities [4–8]. Among these previous studies, Rosch and Lloyd [4] shows that categories have two fundamental properties: the level of abstraction and the prototype. The level of abstraction can be defined roughly by the level of description of an object (from less to more specific). The prototype is the member that best represents a category. This structure of knowledge influences the way we perceive the world, by producing waiting, selection or planning effects. It is a top-down process of the perception. This means that the way one perceives the world depends not only on the ability to collect and process sensory information (light, sound, etc.), but also on what has been learned about the world. It is an interactive process. A categorization task is therefore an experimental way to get an idea of how people organize their knowledge, and how they collect information about the world in terms of similarities [5].

* Corresponding author. Address: SMTS-IRCAM-CNRS, 1 Place Igor Stravinsky, 75004 Paris, France. Tel.: +33 6 1749 6300.
E-mail address: tardieu@ircam.fr (J. Tardieu).

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In the context of public spaces such as train stations, the assumption is made that people have learned how to use these places and how to recognize where they are by learning the typology of spaces. The typology of spaces in a train station is composed of six types: (1) platform, (2) hall, (3) corridor/stair, (4) waiting room, (5) ticket office, and (6) shop. This selection (also presented in [9,10]) of six types of spaces is the result of a typological study made as a preliminary step to the work presented here. This study was mainly based upon previous work at the SNCF and interviews with several architects from AREP (the department in charge of acoustics and architecture for SNCF train stations). The selection is made from the users' point of view, i.e. the 6 spaces selected are those that are the most common for travelers in train stations. Rémy [11] has shown that auditory transitions between these spaces are an important element for the global sound-quality judgment of a train station.

This paper's aim is to show that people also have knowledge of the soundscapes of train station spaces so that they can collect information from them and use it during their stay. This information could concern the objects that are present in the spaces, the type of events that are happening, or the type of space where all these sounds occur.

In other words, the two goals of the study presented here are (1) to reveal the different types of auditory information that are perceived in the soundscapes of train stations and (2) to determine those that participate in the recognition of the space typology. According to previous work on the perception of urban soundscapes [12–15] or interior noise in trains [16–18], a first assumption is that two kinds of auditory information can be found: sound sources and human activities. In addition, in the specific case of closed spaces, it has been shown that information can be extracted from room effects (e.g. reverberation or echoes that specify the room size or wall layout) [19]. This is the third type of sound information that may be used by people in a train station.

To reach goals (1) and (2), the methodology developed in this study is divided into two main steps. First, a laboratory study (presented in Section 2) is carried out in order to identify the auditory information involved in the perception of soundscapes of the space typology. This study is based on the comparison of two auditory experiments carried out with the same sound samples: a free categorization task with verbalization and a six-alternative forced-choice recognition task. In a second step, an *in situ* questionnaire survey (presented in Section 3) is carried out in order to estimate the relevance of the results given by the laboratory study. Finally in Section 4, results of the two steps are compared and discussed.

2. Laboratory study

2.1. Methodology

The goals of this laboratory study are firstly to reveal the sound information that is involved in the perception of soundscapes in train stations, and secondly to show how this information is structured (in terms of categories of objects and events) and contributes to the recognition of the type of space within a typology of six spaces (platforms, halls, corridors/stairs, waiting rooms, ticket offices, and shops). The methodology used is based on the comparison of two auditory experiments: free classification and recognition. This kind of methodology was used in previous work [20] in order to identify the acoustical similarities corresponding to a typology of sound signals for a web-based radio program.

The aim of the free categorization task was to identify the knowledge that is involved in the perceptual representation of the soundscapes of the spaces that make up a train station. In Experiment 1, listeners were asked to classify 66 soundscape samples in a free-categorization task. They also wrote free verbalizations to describe their classification strategy. The aim of the second experiment was to check whether listeners are able to identify the type of space just by listening to the soundscape recordings. Thus, in Experiment 2 another group of listeners was asked to identify each of the 66 sound samples as one of the six proposed types. The two experiments used the same sound corpus described below, which presumes that the two groups of participants used the same sound information. Experiment 1 will provide a description of the sound information used by the participants to group freely the sound samples. Recognition of the space in Experiment 2 is also based on sound information, and a comparison with Experiment 1 indicates what sound information is combined to identify each type of space.

2.2. Recording of sound samples

2.2.1. Technique

The sound samples were recorded with an Ambisonic microphone (Soundfield ST250) on a DAT Sony PC204Ax, all of which is stand-alone with batteries. The digital tapes were then downloaded to a PC through a Sony PCIF-5 interface using the PCscanII software to save the 4-channel.wav files. Ambisonic was chosen because it can be replayed on any type of sound reproduction system [21,22] (binaural, transaural, stereo, and multichannel), and it has been shown that it was well suited for improving the sense of immersion [15]. Finally, the sound samples were binaurally decoded using the Kemar head-related transfer function (HRTF) and diffuse-field equalization.

2.2.2. Recordings location

The recording locations were chosen in order to have a representative sample of the space typology described in the introduction. Six French train stations were chosen: Avignon TGV, Bordeaux St Jean, Lille Flandres, Nantes, Paris Gare de l'Est and Rennes. Sound samples that were representative of the soundscapes under normal conditions were collected in each station. Unusual auditory events, such as demonstrations or construction work, were avoided in the recordings. Moreover, a table[1] was used in which the date, place, and all sound sources that were supposed to be found in those places were indicated. Finally, in each train station and in each type of space, at least five recordings of about 3 min were made. For example, a hall was recorded in several configurations: a small or large number of people, with and without an announcement, with and without the sound of the departure board. The recording sessions lasted six days. A total of nine hours were recorded during these sessions. In addition to the experimental need for these recordings, this represents a large and unique database of sound samples for the SNCF.

2.2.3. Stimuli

A selection of samples that were representative of the soundscapes of the 6 six different spaces was made by four people (i.e. the experimenter and three colleagues from the laboratory), working individually. The goal of the selection was to form a database of sound samples that were representative of each space in terms of sound sources and human activities. The selection made it possible to remove samples of poor sound quality. Sixty-six sound samples were finally selected according to several criteria: sound quality of the recordings, no unusual event, presence of expected sound sources[2] for each type of space.

Table 1 gives the names used for each sample, with a description of the prefixes and suffixes used (each sample is named *prefix_suffix* where *prefix* corresponds to the train station and *suffix* corresponds to one of the six types of space). This table shows that fewer samples were selected for the shops: five samples versus 16 samples for the halls. This is due to the fact that shops were less represented in the train stations than the other types of space. All the samples were 15 s in duration and were equalized in loudness by one person. Table 2 gives a description of each sound sample in terms of sound sources (see Section 2.5.1). These sound sources correspond to the table used during the recording sessions to which are added other sources.

Table 1
Codes used to refer to the stations (prefixes) and spaces (suffixes) of the 66 soundscapes samples in the two auditory experiments

Prefix	Train station	Total	Suffix	Space	Total
av	Avignon TGV	10	p	Platforms	10
bx	Bordeaux St	10	h	Halls	16
li	Lille Flandres	10	c	Corridors	12
na	Nantes	14	w	Waiting	13
pe	Paris Est	10	t	Ticket offices	10
re	Rennes	12	s	Shops	5
Total		66			66

2.3. Experiment 1: free categorization and verbalization

2.3.1. Stimuli

The 66 sound samples were amplified by a Yamaha P2075 stereo amplifier and presented binaurally on a Sennheiser HD 250 linear II headphone. The participants were seated in a double-walled IAC sound booth. The experimental session was run using a Matlab interface running on an Apple G4 computer. At the beginning of a session, the 66 sound samples were randomly placed on the screen. The level of each sample was between 65 and 70 dB(A).

2.3.2. Participants

Fifty-one participants (21 women and 30 men, between 25 and 45 years old) were recruited for this experiment. None of them reported having hearing problems. Participants who reported having a good experience with traveling by train were selected. They knew only that they would listen to soundscapes of train stations, but no information about the space typology was given.

2.3.3. Procedure

This first experiment employed a free-categorization task with free verbalizations. The session was divided into three steps. In a first step, the participants were asked to create as many groups of sound samples as they wanted based on their own similarity criteria. They could listen to the sound samples as many times as they wished to. They could not interrupt the sound until it ended. This first step was about 45 min long depending on the participant's ability to answer quickly. In a second step, using the keyboard, the participants were asked to describe each group they had created previously, in order to explain their classification. Finally in a third step, they were asked to choose a prototype sound sample from each group (See Appendix A.1 for complete instructions). According to [4], a category is built around one or several prototypes, i.e. the elements that share the most properties with all elements of category.

2.4. Experiment 2: space recognition

2.4.1. Stimuli

The sound samples used in Experiment 2 are the same as those in Experiment 1 (see Section 2.3.1).

2.4.2. Participants

Thirty-eight new participants (17 women and 21 men, between 25 and 45 years old) were recruited for this experiment. Participants who reported having a good experience with traveling by train were selected. Before the session, the participants were informed by email of the definitions of the six types of spaces in order to avoid any ambiguity about space names during the session and to make them recall what they knew about these spaces.

[1] This table was based on a technical report (inside SNCF) about acoustics in train stations added to preliminary observations in real conditions.

[2] These sources correspond to the table used for the recordings, added to new sound sources observed during the recording session.

Table 2
Description of the sound sources and events that appear in the 66 soundscape samples

Sound		Sound sources																			
		Punching machines	Departure board	Train noises	Announcements	Whistle	Departure ring	Doors	Wheeled suitcases	Coins	Bar noises	Office noises	Ticket dispenser	Music	Paper	Stairs	Air conditioning	Voices	Urban noises	Steps	Background noise
Platforms	av_p	.	.	X	X	X	.	.	.	.	.	.	.	X	.	.	.	X	.	.	.
	bx_p1	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
	bx_p2	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Xt
	li_p1	.	.	X	X	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Xt
	li_p2	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	Xt
	na_p1	.	.	X	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	.
	na_p2	.	.	X	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
	pe_p	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.
	re_p1	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	X	.
	re_p2	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
Halls	av_h1	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	.	X	.	.	X
	av_h2	.	.	.	.	.	.	X	.	.	.	.	.	X	.	.	.	X	.	.	X
	bx_h1	X	X	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	.	Xt
	bx_h2	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	X	Xt
	li_h1	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	Xt
	li_h2	.	.	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	Xt
	na_h1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	Xt
	na_h2	.	X	.	.	.	.	.	.	.	.	.	X	.	.	.	.	X	.	X	Xt
	na_h3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	Xt
	na_h4	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	Xt
	pe_h1	.	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X
	pe_h2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X
	pe_h3	X	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X
	pe_h4	.	.	X	.	.	.	.	.	.	X	.	.	X	.	.	.	.	.	X	X
	re_h1	X	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X
	re_h2	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X
Corridors/ Stairs	av_c1	.	.	.	.	.	.	X	.	.	.	.	.	X	.	.	.	X	.	X	Xt
	av_c2	.	.	.	X	X	.	.	.	.	.	.	.	X	.	.	.	X	.	X	Xt
	bx_c1	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	.	X	.	X	Xt
	bx_c2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.	X	Xt
	li_c1	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X	.	.	.	X	Xt
	li_c2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.	X	Xt
	na_c1	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.
	na_c2	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	Xt
	pe_c1	X	.	.	.	.	.	.	X	.	.	.	.	X	.	.	.	X	.	X	Xt
	pe_c2	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	X	X
	re_c1	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X
	re_c2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.	X	.

(*continued on next page*)

Table 2 (*continued*)

Sound		Sound sources																			
		Punching machines	Departure board	Train noises	Announcements	Whistle	Departure ring	Doors	Wheeled suitcases	Coins	Bar noises	Office noises	Ticket dispenser	Music	Paper	Stairs	Air conditioning	Voices	Urban noises	Steps	Background noise
Waiting rooms	av_w1	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	X
	av_w2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	X
	bx_w1	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X	.	.	.
	bx_w2	.	.	.	X	.	.	X	.	.	.	.	.	.	X	.	.	.	.	.	X
	li_w1	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X	X	.	.	Xt
	li_w2	.	.	.	X	.	.	.	.	.	.	.	.	X	X	.	X	X	.	.	Xt
	na_w1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	X	.
	na_w2	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
	na_w3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	pe_w1	.	.	.	X	.	.	X	.	.	.	.	.	.	.	.	.	X	.	.	X
	pe_w2	.	.	.	.	.	.	X	.	.	.	.	.	.	.	.	.	X	.	.	.
	re_w1	.	.	.	X	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	re_w2	.	.	X	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.
Ticket offices	av_t1	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	X	X	.	.	.
	av_t2	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	X	.	X	.
	bx_t1	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	X	X	.	X	X
	bx_t2	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	X	X	.	.	X
	li_t1	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	X	X	.	.	X
	li_t2	.	.	.	.	.	.	.	.	.	.	X	.	X	.	.	X	X	.	.	X
	na_t1	.	.	.	.	.	.	.	.	.	.	X	.	.	.	.	.	X	.	X	Xt
	na_t2	.	.	.	.	.	.	.	.	X	.	.	.	.	.	.	.	X	.	X	.
	re_t1	.	.	.	.	.	.	X	.	.	.	X	.	.	.	.	.	X	.	.	.
	re_t2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.
Shops	av_s	X	.	.	.	.	.	.	.	X	X	.	X	.	.	.	.	X	.	.	X
	na_s	.	.	.	.	.	.	.	.	.	X	.	.	X	.	.	.	X	X	.	X
	pe_s	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	X	.	X	Xt
	re_s1	.	.	.	.	.	.	.	.	.	.	.	.	X	.	.	.	X	.	.	Xt
	re_s2	.	.	.	X	.	.	.	.	.	.	.	.	X	.	.	.	X	.	X	X

For the sound source “background noise”, Xt indicates the presence of a tonal component in the background noise of the sample.

2.4.3. Procedure

This second experiment consisted of a six-alternative forced-choice recognition task. At the beginning of the session, the 66 sound samples were randomly placed on one half of the screen. On the other half, six rectangular boxes were drawn and named with the names of the spaces: “Plat-

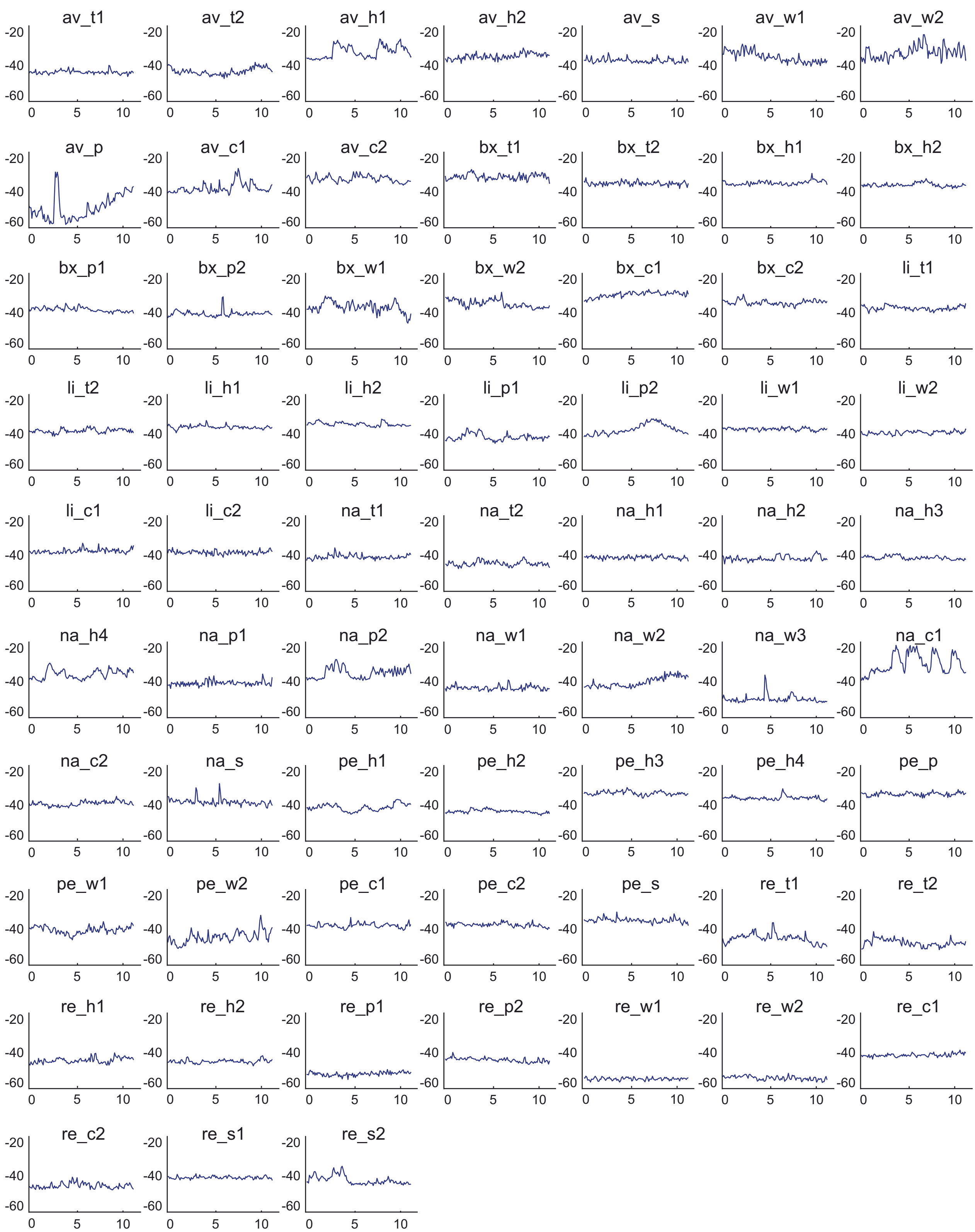

Fig. 1. Sound level variation of the 66 sound samples used for Experiments 1 and 2 (see Table 2 for a description of each sound sample). Each panel gives the variation for the corresponding sound sample. The *x*-axis gives the time (125 ms steps), and the *y*-axis gives the level in dB.

forms", "Halls", "Corridors, Stairs", "Waiting Rooms", "Ticket Offices", and "Shops". In a first step, participants had to listen to all the sound samples and to guess in which of the six spaces each sound was recorded. They could listen to the sound samples as many times as they wished to. They could not interrupt the sound until it ended. All of the sound samples had to be classified in one of the six spaces. In a second step, they had to choose one sound sample per space as a prototype of the space (see Appendix A.2 for complete instructions). Since this was a recognition experiment, the participants were not asked to produce any verbalization.

2.5. Results

A description of the sound sources and an acoustical analysis performed on the 66 sound samples is first presented. Then each experiment is analyzed separately. Finally, Experiments 1 and 2 are compared.

2.5.1. Acoustical description

2.5.1.1. Sound sources. Each sound sample was described by taking notes during the recording session and during several replays of the sound samples. The description gives all the sound sources that are present in the sound samples (ex: ticket punching machines, announcements, wheeling suitcases, trains, etc.). The descriptions are given in Table 2.

The descriptions also indicate the presence of "background noise" in the sound samples. This background noise corresponds to the part of the sound that is quasi-constant in level, or that has very few variations. It can be divided into two types: it can be tonal if a particular frequency is dominant (indicated by the symbol Xt in Table 2), or it can be broadband when no particular set of frequencies is dominant.

2.5.1.2. Sound level evolution. Another relevant aspect of the soundscapes is the variation of the sound level of the acoustical signal. Fig. 1 gives the sound level variation (in dB) over time of each sound sample. This figure reveals differences between the soundscapes in which events happen (e.g. samples av_h1, av_w1, av_w2, etc.) and those with very few or no events (e.g. sample li_w1, li_w2, etc.).

2.5.2. Experiment 1

The data were analyzed in two parts. First, a cluster analysis was performed on all the classifications of the 66 sound samples made by the 51 participants. This first analysis gives the global classes that represent the groupings across the whole set of participants. Second, a lexical analysis was performed on the verbalizations in order to explain the classes obtained with the cluster analysis.

2.5.2.1. Cluster analysis. Fig. 2 shows the results of the cluster analysis made on the 51 classifications. This result is represented by a tree in which each leaf corresponds to a sound sample. The distance between two sounds or two groups of sounds is given by the height of the node between them. For example in the top of Fig. 2, the distance between the samples li_t1 and li_t2 is about 0.4. The distance between these two sounds and bx_w1 is about 0.58. In order to find the classes corresponding to the classifications

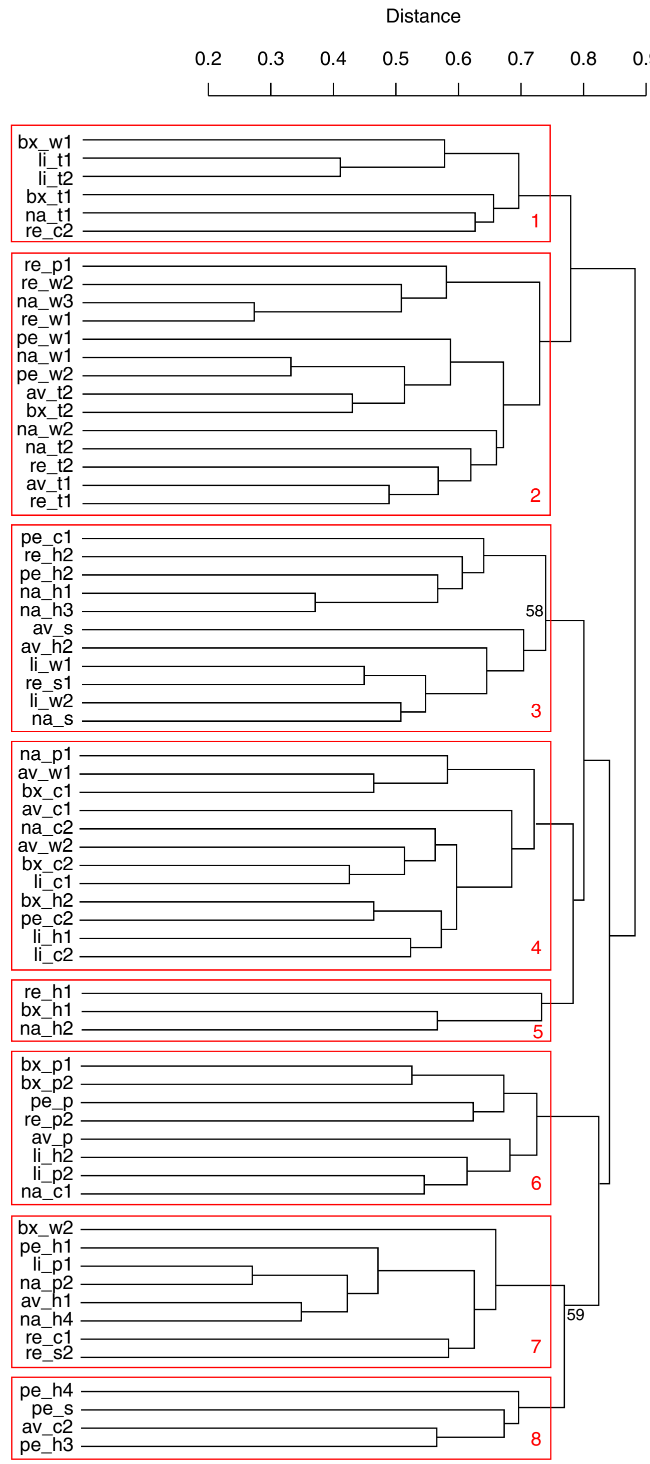

Fig. 2. Dendrogram representing the data of Experiment 1. Results of the hierarchical cluster analysis (average linkage method). The rectangles give the eight classes found with the optimal partitioning analysis.

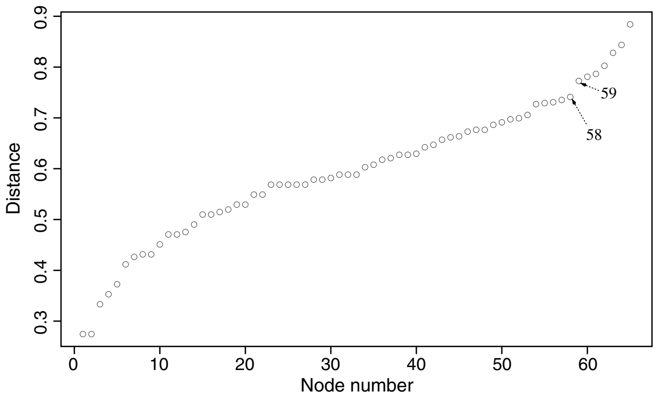

Fig. 3. Node heights of the tree given in Fig. 2. The node height is the same as the distance in the tree.

made by all the participants, we needed to interpret this tree. Two techniques were used. The first one, presented in [23], consists of looking at the node heights in the tree and detecting a gap in order to find two nodes between which the tree must be cut. Fig. 3 shows the node heights of the tree; the node number is given by the x axis. Four gaps can be detected: between nodes 2 and 3, 5 and 6, 58 and 59, and 64 and 65. Cutting the tree between these four gaps gives 64, 60, 8, or 2 classes, respectively.

The second method is based on the calculation of the Rand index and a bootstrap technique applied to the data (this method was first developed in [24]). The Rand index measures the coherence between two partitionings of the same corpus of items [25,26]. The bootstrap consists of re-sampling the original data on a per-participant basis in order to build new trees (called bootstrap trees). Given a reference sample of N observations (here the 51 partitions), we create new samples of observations (called bootstrap samples) by performing a random selection with replacement of N observations within this reference sample. For example, a bootstrap sample could be made of 2*P1, 0*P2, P3, P4, etc., where Pi is the classification of participant i. Then we build a new tree (bootstrap tree) from this bootstrap observation. Each bootstrap tree is compared to the reference tree by calculating the Rand index at different levels of classification (2 classes, 3 classes, etc.). According to [27], 500 bootstrap trees are enough to have a reliable result. The optimal partition corresponds to the number of classes for which the Rand index mean is maximal, and the standard deviation is minimal. Applied to our data, the result of this bootstrap procedure gives eight classes. Since eight classes are indicated by both methods, we then proceed with this result. In addition, 2, 60 or 64 classes given by the first technique correspond to a level either too general or too detailed to explain all 66 selected samples. These eight classes are indicated by the rectangles in Fig. 2.

2.5.2.2. Lexical analysis. Given the eight classes found with the cluster analysis, the issue is now to explain these classes in terms of the verbalizations of the participants and the acoustical descriptions of the samples. The lexical analysis was performed on a selection of the groups made by the participants. A group was selected if it was made of at least 50% of the sounds that are present in one of the eight classes revealed by the cluster analysis. This selection gave 279 texts, with 43 for Class 1, 29 for Class 2, 22 for Class 3, 32 for Class 4, 36 for Class 5, 30 for Class 6, 38 for Class 7, and 49 for Class 8. Each verbalization was reduced to the words that contain a descriptive meaning. For example (translated from the French), the text "I have grouped here the sequences that were taking place in a ticket office. We clearly hear people talking about price and ticket categories" is reduced to the words "ticket office, clearly hear, people, talking about price". This reduction was made with the help of the software LEXICO [28], which automatically counts every word in a text. Then, words are grouped into semantic fields that are deduced from the verbal descriptions. Five semantic fields were deduced and are presented in the list below (examples in parenthesis are translated from the participants' verbalizations originally produced in French):

- Sound sources (e.g. trains, departure boards, ticket punching machines, whistle, etc.).
- Human activities (e.g. conversations, steps, transaction, departure, etc.).
- Room effect (e.g. reverberation, confined, exterior/interior, etc.).
- Type of space (e.g. waiting room, platforms, halls, etc.).
- Personal judgment (e.g. annoying, pleasant, beautiful, musical, etc.).

The names of these five semantic themes are not extracted directly from participants' terms, but they are deduced from the term groupings. However, the terms grouped into the themes are extracted from the verbalizations.

Table 3 shows a synthesis of the words used for each theme (semantic field) and for each class. The column "%" gives the ratio in percentage of each theme in the description of a class, i.e. the proportion of the terms from each theme compared to the total description. Then, the column "Main terms" gives a synthesis of the words or expressions that have been grouped in each theme. An empty cell means there was no consensus in all the terms used. This table shows that Classes 1 and 4 are mainly described with human activities, whereas Classes 5–7 are mainly described with sound sources. Descriptions of Class 2 mainly concern human activities, room effects and positive judgments. Finally, Classes 3 and 8 have no dominant theme, their descriptions being a combination of all the themes.

2.5.2.3. Prototypes. The result of the prototype choice is simply analyzed by counting the number of times each sample has been chosen as prototype. Then, for each of the 8 classes, only the samples with the highest score are

Table 3
Lexical profiles of the eight classes of Experiment 1

Theme	Class 1 %	Main terms	Class 2 %	Main terms	Class 3 %	Main terms	Class 4 %	Main terms
Sound sources	16	Tickets dispenser	10	–	25	Announcements, music	18	Wheeled suitcases
Human activities	41	Conversations, waiting, steps	25	Voices, people	28	Waiting, conversations	48	Steps, walking, voices
Room effect	21	Close room, small space	32	Closed space, small	20	Reverberation confused	15	Echoes, resonances
Type of space	16	Waiting room, ticket office, bar	14	Bar, waiting room, ticket office	16	Bar, hall	8	Corridor, hall
Judgment	6	Quiet, intimate	19	Quiet, intimate	11	Unpleasant	11	Noisy, rhythmic
	Class 5 %	**Main terms**	**Class 6 %**	**Main terms**	**Class 7 %**	**Main terms**	**Class 8 %**	**Main terms**
Sound sources	48	Departure board, train, announcements	44	Trains, announcements	52	Jingle, announcements	28	Music, trains
Human activities	14	Conversations	27	Arrivals, departures	20	Voices, arrivals, departure	28	Voices, conversations
Room effec	14	–	6	External	15	Resonances, reverberation	17	Large reverberation
Type of space	5	–	10	Platforms	4	Hall	12	Hall
Judgment	19	Rhythmic	13	–	9	–	15	Noisy, unpleasant

The column "Theme" gives the themes obtained from the lexical analysis performed on all the verbalizations. The column "%" gives the ratios of each theme, i.e. the ratio of the number of terms for each theme compared to the total number. The column "Main terms" gives a synthesis of the terms grouped under each theme during the lexical analysis.

kept (multiple prototypes can be found). The acoustical descriptions of the prototypes are taken from Fig. 1 and Table 2.

Class 1. The prototype bx_w1 fits well with the lexical profile of Class 1. This sample is characterized by conversations and a clear sound source (newspaper) in a space with very short reverberation time.

Class 2. Three prototypes were found for this class: pe_w2, na_w3 and av_t1. In a coherent fashion with the lexical profiles, the acoustical characteristics are similar to Class 1 (short reverb, few sound sources), but the human activity is lower, and the sound level is low. This characteristic explains the main difference between these two classes: Class 2 is judged to be much more intimate than Class 1.

Class 3. The prototype li_w1 is partially coherent with the lexical profile. It contains clear sounds of music, no activities, a very present background noise, but no spoken announcements like other samples of this class.

Class 4. The acoustical characteristics of the prototype, bx_c1, are very well fitted to the lexical profile: step noises, wheeled suitcases, escalator and conversations. Moreover, the sound level is high (see Fig. 1).

Class 5. The prototype is na_h2, characterized by constant background noise with a sequence of clear sound sources (voices, ticket dispenser, departure board, steps and punching machine). This is coherent with the lexical profile, especially with the aesthetic judgment.

Class 6. Three prototypes were found: na_c1, av_p, li_p2. All of these samples contain the sound of a passing train, in three different types of room effects (respectively, closed, external and large reverb). This confirms the lexical profile, which is mainly based on train noises.

Class 7. The three prototypes of this Class (na_p2, av_h1, li_p1) contain a spoken announcement, which is the main acoustical similarity used to form this class.

Class 8. The prototype is av_c2, characterized by music, step noises, a spoken announcement in the background, a whistle, all of this in a high-level background noise (see Fig. 1). This acoustical description confirms the lexical profile of Class 8, especially with the negative and noisy judgment.

This lexical analysis reveals that the eight classes are explained by one or a combination of the five semantic fields used in the verbal descriptions. Some classes are clearly based on one semantic field (Classes 1 and 4 on human activities, Classes 5–7 on sound sources). Other classes (2, 3, and 8) are less clear, with no dominant theme.

The acoustical description of the prototypes chosen by the participants helps to clarify the differences between the eight classes. The role of the prototype in the construction of a category is underlined by this result, which is coherent with the principles presented in [4].

2.5.3. Experiment 2

This second experiment is analyzed into two steps. First, the recognition scores are calculated, in order to show whether each space is well recognized or not. Second, a cluster analysis is performed on the partitions of the 38 participants, using the same method as in Experiment 1. The classes given by this cluster analysis are finally be compared to the classes of Experiment 1 in order to deduce the acoustical information involved in recognition of the spaces.

2.5.3.1. Recognition scores. Table 4 shows the recognition scores for each type of space. This result should be read horizontally: for example, the first line shows that the sound samples recorded in platforms were recognized by 67% of the participants as platforms, by 12% as halls, by 7% as corridors, by 9% as waiting rooms, by 1% as ticket offices and by 4% as shops. This table shows a diagonal that is greater than 50% for all the spaces, except for the waiting rooms (45%). Given the experimental task (forced choice with six alternatives), if the participants had made a random choice, this would have given a score of 16.6% in each cell of the table. In addition, results show that 44 sound samples (66%) were put in the right category by more than 50% of the participants, and 61 sound samples (92%) were put in the right category by more than 16% of the participants. Also, a chi-square test was performed with different values of p (0.05, 0.01, and 0.005), and the null hypothesis of a random classification. The chi-square test shows that:

- For $p = 0.05$, re_p1 and bx_w2 are randomly classified.
- For $p = 0.01$, re_ p1, bx_w2 and na_ w2 are randomly classified.
- For $p = 0.005$, re_ p1, bx_w2, na_ w2 and na_hn01 are randomly classified.

The fact that so few sound spaces were randomly classified confirms that the majority were correctly classified.

2.5.3.2. Cluster analysis. Fig. 4 presents the hierarchical tree given by the cluster analysis performed on the data of Experiment 2. In order to find the classes made by the 40 participants, a node height calculation was also performed. This gave six classes, represented by the rectangles in Fig. 4. In addition (two columns in the left panel of Fig. 4), this figure shows the sample composition and the best recognition score for each class.

The recognition scores show that each of the six classes is associated with one type of space by more than 50% of the participants. This result confirms the recognition scores of the space typology given before.

The composition column shows that almost all samples from each space remain together in one separate class. Also, except for Class 2, all the classes are mainly made of one type of space. Class 2, associated with Shops by 57% of the participants, is composed of three of the four shop samples to which samples from each type of space (except platforms) are added. This means that the Shop category is bigger than the initial sample category (see Table 1). This could be explained in two ways: (1) the Shop category corresponds to "unclassifiable sound samples", i.e. all ambiguous samples are associated with shops or (2) shop samples being less numerous than other spaces, participants tried to equilibrate the shop category.

2.5.3.3. Prototypes. The result of the prototype choices shows that for four of the six categories (halls, waiting rooms, tickets offices, and shops), the prototype corresponds to the sample with the best recognition score. For the spaces Platforms and Corridors, the prototype does not have the highest recognition score. This means that, for these two spaces, the recognition score is not a good predictor of typicality.

Platforms. For this category, the prototype (av_p) has a score of 84% against 97% for the sample li_p2. The sample av_p corresponds to an external platform, with music, a train arriving, and a whistle. The sample li_p2 is only characterized by the sound of a train passing over the entire sample duration.

Halls. The prototype na_h4 has the best score (95%). It is characterized by a high-level background noise, a spoken announcement, dense human activity and the sound of the mechanical departure board.

Table 4
Recognition scores of Experiment 2

Spaces	Associated spaces					
	Platforms	Halls	Corridors	Waiting rooms	Ticket offices	Shops
Platforms	*67*	12	7	9	1	4
Halls	19	*52*	11	6	4	8
Corridors	16	14	*55*	2	5	8
Waiting rooms	6	7	12	*45*	9	21
Ticket offices	2	4	2	11	*53*	28
Shops	3	20	5	5	9	*57*

Each line gives the recognition score (in percent) for each type of space.

Associated space	Composition
Waiting Rooms 66 %	1/8 Hall 7/8 Waiting Rooms
Shops 57 %	2/11 Halls 1/11 Corridor 3/11 Waiting Rooms 2/11 T. Offices 3/11 Shops
T. Offices 56 %	1/10 Corridor 8/10 T. Offices 1/10 Shop
Corridors 73 %	8/10 Corridors 2/10 Waiting Rooms
Platforms 71 %	9/11 Platforms 1/11 Hall 1/11 Corridor
Halls 71 %	1/16 Platform 12/16 Halls 1/16 Corridor 1/16 Waiting Rooms 1/16 Shop

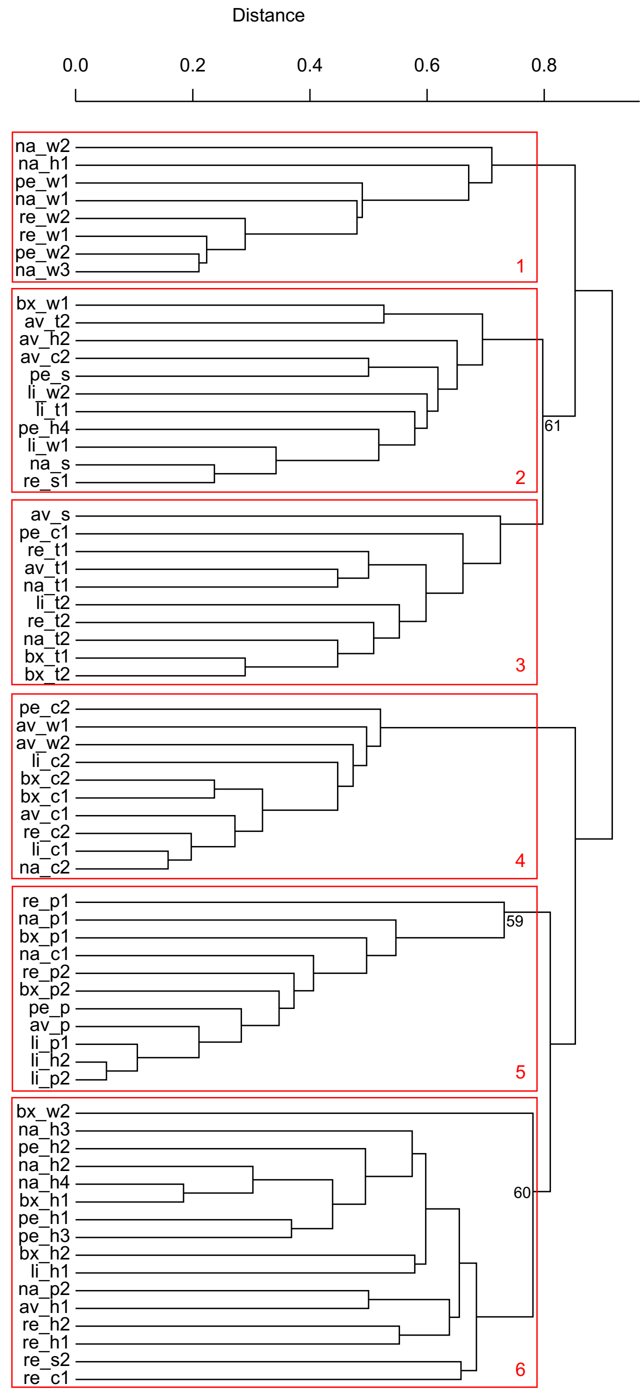

Fig. 4. Dendrogram of Experiment 2 results. Results of the hierarchical cluster analysis (average linkage method). The rectangles give the six classes found with the complementary analysis. The Composition column gives the sample composition of each Class in terms of proportions. The Associated Spaces column gives the main recognition score of each class.

Corridors. The prototype, bx_c1, has a score of 71% against 92% for li_c1. In terms of sound sources, these two samples differ with three items (ticket dispenser in li_c1, voices and wheeled suitcases in bx_c1), but both have lot of step noises, and a high level of background noise. But, in terms of room effect, bx_c1 sounds like a more enclosed space. This difference then explains that bx_c1 is more representative of corridors for the participants.

Waiting rooms. Two prototypes were found for this class, pe_w2 (score of 89%) and na_w1 (score of 66%). These two samples are characterized by a very calm soundscape, clear voices, and very few sound sources.

Ticket offices. The prototype for this Class is bx_t2 (score of 92%). It is a calm soundscape, in which we can clearly hear a conversation between a seller and a customer. In other words, participants recognized the type of space by identifying the type of activity.

Shops. The prototype na_s has the best score (97%) and is characterized by music, sound of spoons and clearly audible conversations.

2.5.4. Experiment 1 versus Experiment 2

The last step of the analysis consists of comparing the classes of the two experiments in order to explain the classes of Experiment 2, i.e. to find the sound information picked up by the participants to identify the spaces.

Table 5 compares the composition of the six classes of Experiment 2 to the composition of the eight classes of Experiment 1. To deduce the lexical profiles (or sound signatures) of the six spaces, Table 5 is reduced to the most representative parts from the classes of Experiment 1. For example, the Hall class is composed of all the samples from Class 5, added to almost all the samples from Class 7. The other groups of samples of the Hall class are not representative of Experiment 1 classes. Then, the Hall class inherits both the lexical profiles of Classes 5 and 7. Thus, the following correspondence is deduced:

- Platforms = Class 6
- Halls = Class 5 + Class 7
- Corridors = Class 4
- Waiting rooms = half of Class 2
- Ticket offices = Class 1 + half of Class 2
- Shops = Class 8 + Class 3

Table 6 gives the sound signatures for each space of the typology deduced from this correspondence. The sound signature for each space is given by putting together the lexical profiles of each corresponding class or group of classes.

2.6. Conclusions of the laboratory study

The previous section presented the results of a laboratory study on the perception of soundscapes in train stations. Two main results are given by the experiments. First, given a sound corpus composed of 66 representative sound samples recorded in existing train stations, a first auditory experiment (Experiment 1) showed that listeners formed eight classes of sounds. These eight classes are explained with the free verbalizations of the listeners, and the lexical descriptors used can be divided into five semantic groups: sound sources, human activities, room effects,

Table 5
Experiment 1 versus Experiment 2

Classes of E1	Classes of E2					
	Platforms 11 snds	Halls 16 snds	Corridors 10 snds	Waiting Rooms 8 snds	Ticket Offices 10 snds	Shops 11 snds
Class 1 6 snds			1		3	2
Class 2 14 snds	1			7	5	1
Class 3 11 snds		3		1	2	5
Class 4 12 snds	1	2	9			
Class 5 3 snds		3				
Class 6 8 snds	8					
Class 7 8 snds	1	7				
Class 8 4 snds		1				3

Comparison between the classes of Experiment 1 and the classes of Experiment 2. For example, the first column shows that the Platforms class of Experiment 2 is composed of 11 sound samples with one from Class 2 of Experiment 1, one from Class 4, eight from Class 6 and one from Class 7.

Table 6
Sound signatures of the six spaces

Theme	Platforms		Halls		Corridors	
	%	Main terms	%	Main terms	%	Main terms
Sound sources	46	Trains, announcements	50	Trains, announcements, departure boards	16	Wheeled suitcases, machines
Human activities	25	Arrivals, departures, waiting, voices	18	Arrivals, departures,	49	Steps, walking, voices
Room effect	6	External	14	Large reverberation, echoes	16	Echoes, resonances
Type of space	10	Platforms	4	Platforms, halls	8	Hall, corridors
Judgment	13	–	14	–	11	Noisy, rhythmic
	Waiting rooms		Ticket offices		Shops	
	%	Main terms	%	Main terms	%	Main terms
Sound sources	8	–	11	Trains, tickets dispenser, announcements	26	Announcements, music, trains
Human activities	24	Voices, people	34	Voices, people, waiting, steps	28	Voices, people
Room effect	33	Closed space, small reverberation	27	Closed space, small reverberation, isolated	18	Large reverberation, echoes
Type of space	15	Bar, waiting room, ticket office	16	Bar, waiting room, ticket office	14	Hall, bar, waiting
Judgment	20	Quiet, intimate	12	Quiet, intimate	14	Pleasant

This table is the result of the crossing between the lexical profiles of the classes of Experiment 1 (see Table 3) and the composition comparison given in Table 5. For example, the Platforms class is mostly made of the Class 6 of Experiment 1, it thus inherits the lexical profile of Class 6.

type of space (recognition) and personal judgment. This result is coherent with previous work on urban soundscapes [12–15], with however a distinction since the theme called *Room effects* in our study was called background noise in those previous studies. This also confirms the results presented in [19] concerning the perception of spatial cues conveyed by the room effects. This first result suggests that people can collect information from the soundscape of a train station, and that this information is largely composed of sound sources, human activities, and room effects.

The results of a second auditory experiment (Experiment 2) have shown that the majority of the 66 sound samples were classified in the right space category with very few mistakes. This suggests that, given the space typology, people are able to recognize the type of space in which a sound sample has been recorded, just by listening to the soundscape. This recognition is based on auditory information deduced from the first experiment, since each class of Experiment 2 is composed of one or two classes of Experiment 1. This result suggests that the auditory information collected within the soundscape of a space, given by Experiment 1, is also involved in recognition of the type of space. In other words, people's knowledge of the typology of spaces also concerns the soundscapes of these spaces.

3. Experiment 3: *in situ* study

The next step of the methodology consisted of an *in situ* questionnaire survey, the aim of which was to determine whether the acoustical information found in the laboratory is relevant in a naturalistic context [29]. In this survey, people in a train station were asked to describe the soundscape of the space in which they found themselves. The survey took place in the spaces that had the best recognition scores in Experiment 2, i.e. the spaces that best represent the sound signatures given in Table 6. The part of the results of this questionnaire that are relevant to the present study will be compared to the laboratory results in the previous experiments.

3.1. Questionnaire

The questions were prepared in order to incite people to describe the soundscape of the space in which they were situated. Four basic rules were used to create the questions, deduced from previous work [30] and other surveys at the SNCF: (1) The meaning of a question must be the same for the interviewee and the interviewer. (2) To do that, the vocabulary used must be very simple, and the expression must avoid any ambiguity. (3) A question must deal with only one topic, avoiding "and/or". (4) Questions must be written without negation.

A pilot questionnaire was first written and tested with participants *in situ* in order to validate the formulation of the questions. In the final questionnaire, two questions directly concerned the description of the soundscapes. Only the results concerning these questions are reported below (originally in French, they are translated in parentheses and italics for the purpose of this article):

1. Pouvez-vous décire l'ambiance sonore[3] de cet espace en particulier? *(Can you describe the soundscape of this place in particular?)*.
2. Enumérez et décrivez précisément ce que vous entendez. *(Enumerate and describe precisely what you hear.)*

3.2. Procedure

The questionnaire was filled out in the types of spaces that had the best recognition scores in Experiment 2. These locations were on the platform at Avignon TGV, in the Hall at Nantes (Sud), in the corridor under the tracks at Bordeaux St Jean, in the waiting room at Paris Est, in the ticket office at Bordeaux St Jean, and in the shops at Nantes (Nord).

Thirty people participated for each space. An audio recording of the interview was made for further transcriptions with a mean duration of 5 min.

3.3. Results

The results were analyzed in a similar way to the lexical analysis performed in the laboratory study (see Section 2.5.2). All the responses were manually transcribed from the notes and the sound recordings. A lexical analysis was performed on all these texts and organized using the software Stone [31]. This software allows a better organization of the lexical analysis, because it always keeps a direct link to the original text. Therefore, each space was described through the same themes as in the laboratory study. Then, two comparisons were made between the laboratory and the *in situ* conditions on the proportion and the composition of each theme.

3.3.1. General trends

Four main trends are deduced from the first comparison:

- Sound sources are more often used for the descriptions in the *in situ* than in the laboratory study (except for Halls).
- Room effects are much more quoted in the lab that *in situ*, because they are seldom used *in situ* (except for Halls).
- Type of space is never used for the descriptions in the *in situ* study.

[3] Although the term *soundscape* might need to be defined since it is not a widely understood concept, the term *ambiance sonore* is common in French and did not need to be explained.

- Personal judgments are more present for the *in situ* descriptions than for the lab descriptions (except for Shops).

3.3.2. Sound information

For the sound sources, the descriptions are more precise for the *in situ* condition, but are still coherent with the laboratory condition. This trend is quantified by the fact that the number of quoted sound sources is greater *in situ* than in the laboratory. For example, in the descriptions of the platforms, the sound sources quoted *in situ* but not in the laboratory include: suitcases, music, birds, wind, and cars. This difference in precision is mainly due to the fact that *in situ*, people are in a multisensory context in which they can recognize the sources.

For the human activities, the descriptions are mainly similar between the two conditions.

For the room effects, the number of terms used by the participants in the laboratory is greater than *in situ*. This is coherent with the general trend on room effects given before. Listeners in the laboratory described more precisely the reverberation and the general architecture of the space deduced from this reverberation (e.g. waiting rooms, ticket offices and shops). This shows that the reverberant aspect of a soundscape is much more salient in a recorded sample than *in situ*. This is coherent with the principle of "musical listening" when performing a listening test in a laboratory, situation that deals more with analytical listening than with "everyday" listening [1,2].

Finally, for personal judgments, the descriptions are similar for the waiting rooms and the ticket offices between the two conditions. "Pleasant" or "quiet" are the main terms used in the two conditions except for the corridors for which the laboratory description is different with the terms "noisy" and "rhythmic".

4. Conclusion of the *in situ* study

The previous paragraphs presented the results of a questionnaire survey carried out in order to estimate the relevance of laboratory results on the perception of train station soundscapes. In a qualitative fashion, the results of the survey show good coherence with the laboratory results. The verbal descriptions made by the participants in the two conditions belong to the same semantic fields: sound sources, human activities, room effects, and personal judgments (only the semantic field "Type of space" found in the laboratory is not used in real conditions). These semantic fields are also coherent with those found in previous studies on urban soundscapes [12–15] and train cabin soundscapes [16,17]. In this way, these results show that the acoustical information found in the laboratory conditions is relevant in a real context. However, in a more quantitative fashion, the results show that the ratios of each theme that describe each space are mostly different. Indeed, sound source descriptions are more accurate in real conditions, but room effects are more salient in laboratory conditions. In terms of listening context, this can be explained with two main strategies as outlined by Gaver [1,2]: (1) "musical listening" focuses on the sound itself, its characteristics, like room effects for example, and (2) "everyday listening" focuses on the source of the sound. This could be developed in a more exhaustive comparison between laboratory and *in situ* assessments of soundscape perception.

5. Conclusions

This study characterizes the auditory perception of the soundscapes in train stations. Given a typology of spaces that compose a train station, the main finding of this study is to show that people's knowledge about this typology of spaces also concerns the soundscapes. Two laboratory experiments were performed, then an *in situ* questionnaire survey was carried out in order to test the relevance of the laboratory results.

First, Experiments 1 and 2 were performed with a corpus of 66 sound samples that are representative of the soundscapes of existing train stations. In Experiment 1, the statistical analyses of the data show that the listeners grouped the samples into eight classes, described with five semantic themes: sound sources, human activities, room effects, as well as type of space and personal judgment. This result is coherent with work on urban soundscapes [12–15] and spatial hearing [19]. Each class is mainly explained with one theme or a combination of several themes, and those lexical profiles are confirmed by the acoustical characteristics of the prototypes of each class. In Experiment 2, another group of participants was asked to select the type of space in which each of the 66 sound samples was recorded. Very high scores were obtained for all the spaces, which means that listeners were able to associate each sample with the type of space just by listening to it. This result confirms the assumption that the soundscape of a train station conveys information for the people who are listening to it. Moreover, this result confirms that people have a strong perceptual representation of the six spaces of the typology. Finally, since the classes of samples remain mostly the same between Experiments 1 and 2, the lexical profiles of each space are deduced. In addition to the sound characteristics of the prototypes, these results provide a sound signature for each space. The sound signature of a space is made of the elements of the soundscape that are characteristic to this space and that make it different from the other spaces. These sound signatures correspond to the mental representation of the soundscapes of train station spaces.

Second, a questionnaire survey was performed in the spaces that obtained the best recognition scores in the laboratory study. The aim of this survey was to estimate the relevance of the acoustical information given in the laboratory study. In qualitative terms, the results show a good similarity between the verbal descriptions made *in situ* and those made in the laboratory, because the lexical terms used are the same. In quantitative terms, the ratios of each semantic field are different between the two conditions: sound source descriptions are more precise *in situ*, room effects descriptions are more precise in the laboratory. These trends can be explained with two different listening strategies proposed by Gaver: musical and everyday listening [1,2]. However, these results show that the perception of soundscapes can be assessed both in laboratory and real conditions in a complementary way.

In conclusion, the different results presented in this paper confirm that listeners are able to extract auditory information in the soundscape of a public space such as a train station. This information is about what is happening (e.g. the departure board is being refreshed), about the human activities that are performed, or about where they are in the train station (e.g. in a hall, a waiting room, etc.). This means that knowledge that has been learned during living experience in these kinds of public places (e.g. typology, activities or objects that can be found), also concerns the soundscapes and the auditory information that can be used. In a coherent fashion with the psychological principles presented in [4], this knowledge is structured into categories of sound information (sound sources, human activities, room effect) and those categories are built around soundscape prototypes, i.e. elements that are most representative of each category. Finally, this work provides the hypothesis that new kinds of auditory information (in a perspective of sound design for example) will also be learned and integrated in the mental representation of the soundscapes. Then, future work can study the implicit learning of urban sound signals.

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Appendix A. Text instructions for Experiments 1 and 2

The two following sections present the instructions given to the participants at the beginning of each experiment. These instructions where given in French, a translation by the author in italics and parenthesis is provided.

A.1. Experiment 1

A.1.1. Introduction

Tout d'abord merci de participer à cette expérience. Elle s'inscrit dans le cadre d'une thèse sur l'ambiance sonore des gares. Vous allez écouter 66 séquences sonores qui ont été enregistrées dans différentes gares de France. *(Thanks for doing this experiment. It is part of a thesis on soundscapes in train stations. You will listen to 66 sound samples that have been recorded in several French train stations).*

A.1.2. Tâche – Partie 1 (Task – Part 1)

Votre tâche consiste à **former des groupes** de séquences sonores qui vous paraissent similaires. Pour cela vous devez écouter les séquences sonores entièrement, autant de fois que vous le souhaitez. Vous pouvez créer autant de groupes que vous le désirez, avec autant de séquences sonores que vous le souhaitez. *(Your task is to **create groups** of sound sequences that seem similar to you. To do that, you need to listen to the samples entirely, as many times as you want. You can create as many groups as you want, with as many samples as you want).*

A.1.3. Tâches – Partie 2 (Tasks – Part 2)

Dans la première partie, vous avez formé des groupes de séquences sonores. Votre tâche consiste maintenant à: *(In the first part, you created groups of samples. Now your task is to:)*

1. **Décrire chaque groupe** en expliquant les similarités que vous avez perçues entre les séquences sonores d'un groupe. *(**Describe each group** by explaining the similarities you perceived between the samples of the group.)*
2. **Sélectionner pour chaque groupe la séquence sonore** qui le représente le mieux (**prototype**). Vous noterez le numéro du prototype à la suite de la description. *(**Select for each group the sound sample** that best represents the group (prototype). Write the prototype number after your description.)*

A.2. Experiment 2

A.2.1. Introduction

Tout d'abord merci de participer à cette expérience. Elle s'inscrit dans le cadre d'une thèse sur l'ambiance sonore des gares. Vous allez écouter 66 séquences sonores qui ont été enregistrées dans les différents espaces de plusieurs gares de France. *(Thanks for doing this experiment. It is part of a thesis about soundscapes in train stations. You will listen to 66 sound samples that have been recorded in different spaces of several French train stations.)*

A.2.2. Tâche – Partie 1 (Task – Part 1)

Toutes les séquences sonores ont été enregistrées dans l'un des six types d'espace de la typologie dont vous avez pris connaissance. Vous devez **identifier** le type d'espace d'où provient chacune des séquences. Chaque séquence doit être classée dans l'un des groupes correspondants aux six espaces. Vous pouvez les écouter autant de fois que vous le souhaitez. *(Each sample has been recorded in one of the six spaces of which you were informed. You need* *to identify the type of space for each sample. All samples must be classified in one of the six spaces. You can listen to the samples as many times as you want.)*

A.2.3. Tâche – Partie 2 (Task – Part 2)

Dans la première partie, vous avez classé chaque séquence sonore dans l'un des six types d'espaces de la typologie. Votre tâche consiste maintenant à: *(In the first part you classified each sample in one of the six spaces of the typology. Now your task is to:)*

Sélectionner **pour chaque espace la séquence sonore** qui le représente le mieux **(prototype)**. *(Select **for each space the sample** that best represents the space **(prototype)**).*

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