

inter.noise 2000

*The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE*

I-INCE Classification: 6.1

AUDITORY COMFORT ON BOARD OF TRAINS: PASSENGERS POINT OF VIEW

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Keywords:

ACOUSTIC COMFORT, PSYCHOLINGUISTIC, SURVEY, TRAINS

ABSTRACT

To understand the importance of sound in the judgement of comfort on board of trains, two different surveys were performed to find out how passengers judge train journeys and which parameters are contributing to comfort. A "semi-open" questionnaire was constructed on a psycho-linguistic basis. From all the answers to the questionnaire, a sample was selected and classified in order to extract the categories used by the passengers. The present paper briefly explains the methodology involved, presents the major results, and compares the results of the two surveys. The results show the importance of the "auditory" and "vibratory, kinesthetic" aspects of comfort, which are given by the passengers as their first reasons of dissatisfaction. Furthermore, passengers base their judgements on the meaning of sound sources and events they perceive, and a list of those was established. An other major result is the difficulty to directly relate dissatisfaction to physical parameters since comfort is depending on the activities the passengers are involved in. This remark opens to a methodological issue: questioning people about their subjective evaluation of comfort involves taking into account more complex contexts than just auditory perception, not even multimodal perception, but also meanings, purposes and activities while travelling.

1 - INTRODUCTION

For improving the auditory comfort on board of trains, it is important to find out what is relevant for the passengers. Therefore, characterizing the passengers' point of view is the starting approach in this study of comfort. The analysis of this perceptually relevant characterization and its relation to physical measurements would suggest improvements in comfort.

After a brief description of the method used, the results from two different surveys are presented. The first survey was carried out in commercial trains, later called client-survey. The second survey was carried out during a field-test on board a special train, and includes simultaneous psychological and physical measurements, later called field-test.

- The aims of the client-survey were to understand how passengers judge a train journey taken as a whole, which elements are contributing to its comfort, and the importance of sound in judging comfort on board of trains. A further aim is to obtain a list of sound sources together with the judgements they induce.
- The aims of the field-test were on one hand to confirm the precedent results and validate the method used, and on the other hand to correlate the psychological measurements with the physical ones.

2 - METHOD

The methodology chosen for both surveys is based on a psycho-linguistic approach [1], [2] that allows to collect complete information on how passengers feel and think on board of trains. Our "semi-open"

questionnaires were therefore developed: they do not steer the answers of the subjects nor confine them within terms defined beforehand. These questionnaires begin with general questions about the whole journey, then specific questions deal with the auditory perception.

The client-survey took place in commercial trains. The questionnaires contained 16 questions and we collected 220 questionnaires properly filled. The field-test took place on board of a special train running between Paris and Chatellerault, a one and a half hour journey of about 300 km. 58 persons, selected on criteria such as age and train travel habits, were asked to answer to three questionnaires: a "travel log" on which passengers had to write what they perceived during the journey and at which moment (a kilometeric information was digitally displayed in the coach that they had to report on their sheet); a first questionnaire which addressed train journey in general and global comfort; and a second questionnaire on this specific journey and its auditory comfort. This paper only reports the data from the second 26 questions questionnaire.

From all the answers to the questionnaires, a sample was selected. The first step was to transcript all the answers, because the psycho-linguistic analysis specifically pays attention to the way passengers express their judgement of comfort and which words are meaningful. Then, to analyze data, expressions are classified in categories which are selected from the answers themselves. Last, all occurrences in each category are counted for statistical analysis.

This approach has three major advantages [3]:

- it allows the emergence of unknown themes;
- it gives access to the signification of sound sources;
- it gives access to each subject's own way of expressing their judgements.

3 - RESULTS

The results are presented in two parts: part 1 presents the client-survey, and part 2 the field-test together with its comparison with the first survey.

3.1 - Client-survey

Rank of auditory comfort

The first important result concerns the rank of auditory comfort among all the elements of comfort. The results are compiled from the following three questions (the questionnaires were written in French and were translated for this paper):

- Q1: *"Citer cinq raisons pour lesquelles vous avez apprécié ce voyage en train."*
"List five reasons for which you appreciated this train journey."
- Q2: *"Citer cinq raisons pour lesquelles vous n'avez pas apprécié ce voyage en train."*
"List five reasons for which you did not appreciate this train journey."
- Q3: *"Qu'est-ce qui caractérise pour vous le confort du voyage en train?"*
"What characterizes for you the comfort of train journeys?"

A classification of the different elements is presented in Table 1.

Listed elements of comfort	Rank of positive judgements	Rank of negative judgements	Rank of contribution as element of comfort
Seats	4	6	1
Space	4	3	2
Auditory	1	2	3
Visual	3	7	4
Hygiene	2	5	5
Climatic	5	4	5
Vibratory	7	8	6
Kinesthetic	6	1	6
Olfactory	7	5	7

Table 1: Classification of the different elements of comfort 1 represents the most important element and 7 the less important.

Auditory comfort is mentioned in every case as one of the three most important elements, revealing the importance of this parameter of comfort and the worth of studying this parameter.

Secondly, kinesthetic comfort is considered as the main cause of dissatisfaction but appears as a lesser characteristic elements of comfort. This can be explained by the meaning of the words: comfort – at least in French – implies a notion of physical well-being and is positive; whereas kinesthetic elements are only negative and can hardly appear as answer to a question on characteristics of comfort. The words chosen for questioning people influence the answers and it is therefore important to know their semantic value.

Sound sources and events

A second aim is to obtain a list of sound sources and events perceived by passengers. They were collected in response to the following questions:

- Q4: *"Quels sont les bruits auxquels vous avez été sensibles au cours de ce voyage?"*
"What are the noises you have been sensitive to during this journey?"
- Q5: *"Répartissez les bruits précédents (A, B, C...) en bruits agréables, désagréables, gênants, ou indifférents."*
"Distribute the precedent noises (A, B, C...) in pleasant, unpleasant, annoying, or indifferent noises."

Both noises and their judgements are presented in Figure 1. Note the majority of the sources and events cited are taking place inside the coach.

The main sound sources are announcements, mobile phones, the rolling noise, train crossings, people, tunnels, doors and object vibrations. As displayed in Figure 1, mobile phones are negatively judged, announcements are mixed, and the rolling noise is mostly positive.

It is really important to provide a list of sound sources truly perceived by passengers for further surveys. For example, the source "air conditioning", which the engineer knows as an important source of noise, does not seem to be noticed by passengers. They probably attribute this noise to other sources (perhaps to the rolling noise or to the motor noise).

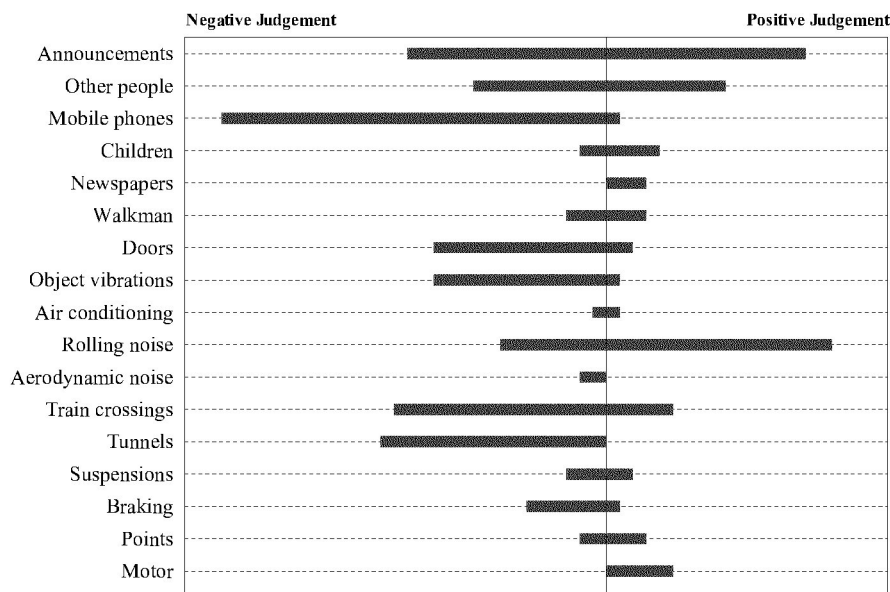


Figure 1: Client-survey – judgements on perceived noises.

An other important result concerns the announcements: their evaluations are ambiguous. Looking closer at the texts of the answers, announcements can be divided in two groups: the announcements from the Railway Company (SNCF) are judged positively (because of their usefulness), whereas the announcements from the bar are less appreciated. It is therefore necessary to separately process this two kinds of announcements.

To sum up, passenger listed relevant sound sources and events, but the actual phrasing of their answers is important, as was shown for announcements.

Practised activities

An hypothesis was built from the results of this survey: the judgements of the passengers are strongly depending on their activities. By practising or non practising an activity, they notice or do not notice the different elements of the comfort of the train and differentially judge. This can be illustrated by the following two answers:

- *R1: "Etant donné que le TGV est silencieux, on peut facilement dormir ou lire."
"As the TGV is silent, one can easily sleep or work."*
- *R2: "Difficulté de stabilité dans les déplacements (il faudrait avoir le pied marin)."
"Difficulties about stability while moving in the train (one should be a sailor)."*

So it seems important to know which activity is practised while judging to validate it.

3.2 - Field-test and comparison

For the field-test, both psychological and physical measurements were carried out. Only psychological measurements are analyzed here. Results are compared to the client-survey in order to deduce some methodological conclusions.

Comparison with client-survey

The results obtained during the field-test are equivalent to those of the client-survey. Auditory parameters are judged as both an appreciated element of comfort and an unpleasant one.

The list of sound sources obtained from the subjects is also similar. The main difference concerns the percentage of other people noticed. As a matter of fact, the coach was not full and the subjects may have been very concentrated on the task of answering the questionnaires.

To evaluate the differences between the field-test journey and a "real" journey, two groups of specific questions were asked, the first group (Q6 and Q7) related to the test journey and the second group (Q8 and Q9) to memorized journeys:

- *Q6: "Au cours de ce voyage, quels sont les bruits dont vous vous souvenez?"
"During this journey, what are the noises you remember?"*
- *Q7: "Classez les bruits précédents en bruits agréables, désagréables, gênants, ou indifférents."
"Classify the precedent noises (A, B, C...) in pleasant, unpleasant, annoying, or indifferent noises."*
- *Q8: "De manière générale, au cours d'un voyage en train, quels sont les bruits auxquels vous êtes sensibles?"
"Generally, during a journey by train, what are the noises you are sensitive to?"*
- *Q9: "Classez les bruits précédents (A, B, C...) en bruits agréables, désagréables, gênants, ou indifférents."
"Classify the precedent noises (A, B, C...) in pleasant, unpleasant, annoying, or indifferent noises."*

The comparison between the field-test survey and the memorized journeys is presented in Figure 2, where the dark bars corresponds to the field-test journey and the light ones to the memorized journey. Results are globally similar. The main difference concerns the category "other people" which groups the original categories "other people", "other people's voices" and "mobile phones". This difference can be explained by the difference in the number of passengers in the field-test and in "real" journeys (more crowded).

The comparison between the field-test and the client-survey (Figure 1 and Figure 2) shows similarities in the responses: the main sound sources are announcements, mobile phones, rolling noise, and other people. The difference between SNCF and bar announcements is also confirmed.

Methodological consequences

The previous comparisons have proved the validity of field-tests to simulate "real" journeys, inasmuch as the perception of sound sources is concerned. Therefore, the correlation between physical and psychological measurements is relevant for evaluating objectively the comfort of "real" train journeys.

4 - CONCLUSION AND FURTHER WORKS

The present analysis constitutes the first results of a psycho-linguistic study of auditory comfort on board of trains. The importance of auditory elements on comfort has been confirmed and a list of sound sources and events that are important and meaningful for the passengers was obtained. The issue of taking into account the activity practised by the passengers has also been raised.

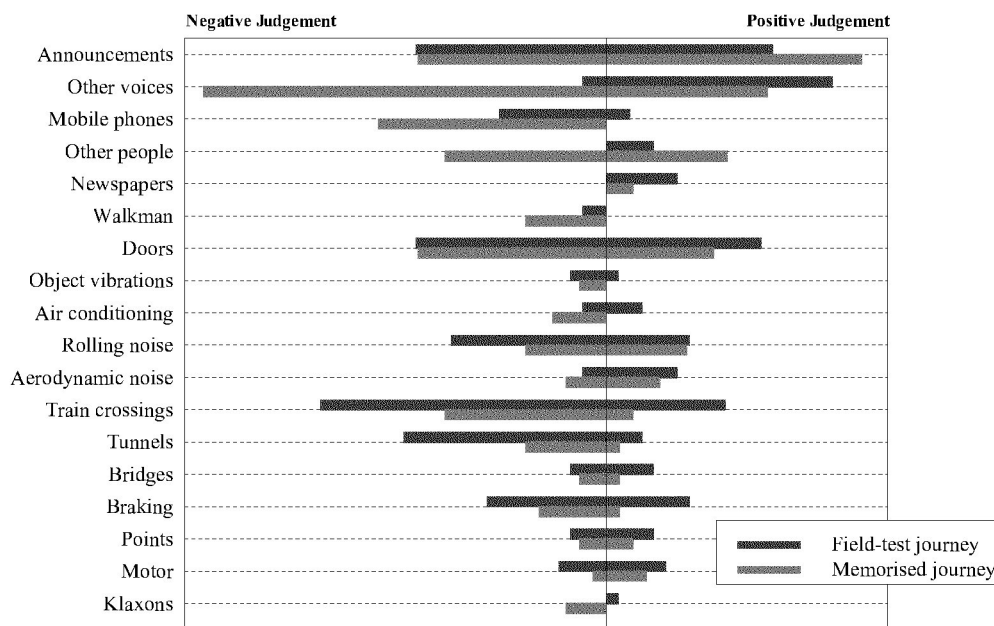


Figure 2: Field-test – sound sources and events – questions 6-7 and 8-9.

The main result is that subjective evaluation carried out in a field-test are comparable to subjective evaluation during a "real" travel. Methodologically, this means that comparing results – both psychological and physical results – obtained for these different conditions is relevant.

The next step of this work concerns the correlation between psychological and physical measurements in order to find out which physical phenomena induce negative perception. The audio-recording realized during the field-test will be used simulate soundscape on board of trains, and listening tests will be performed to evaluate the relevance of sound-only simulations.

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