Soundscape in Restaurants

Monika Rychtarikova[1,2], Gerrit Vermeir[3]

[1] *Institut für Technische Akustik, RWTH Aachen University, D-52056 Aachen, Germany; E-Mail:mry@akustik.rwth-aachen.de*

[2] *STU Bratislava, Dep. Building Constructions, Radlinského 11, Bratislava, 81108, Slovakia*

[3] *Laboratory of Building Physics and Laboratory of Acoustics and Thermal Physics, K.U. Leuven, Belgium; Celestijnenlaan 200D, B-3001 Leuven, Belgium, E-Mail: Gerrit.Vermeir@bwk.kuleuven.be*

Introduction

Besides the home and outdoor environment, people spend an important fraction of their leisure time in restaurants, pubs or public spaces. Soundscape perception stays due to its "invisible" character often subconscious and until now, only little systematic research has been done in establishment of a firm relation between acoustic parameters and subjective acoustic comfort. As a result, the acoustic comfort is not explicitly taken into account in the overall judgement or commercial value setting of food and drink catering establishments and its rating systems such as Micheline etc.

Although the human assessment of the soundscape in a place is always subject to a certain amount of subjectivity, some basic general qualitative features can be expected. Relation between the annoyance criteria and noise levels is evident and a method for rough estimation of noise levels in eating establishments has been proposed by Rindel [1].

Parameters related to human communication can be very useful in this respect as well. If people at the table understand each other, and in the same time, speech privacy in relation with other visitors of restaurant stays reasonable, place is often considered as pleasant.

When human voices dominate the soundscape in the room, several acoustical, psychological and perceptual effects occur. Two of the well known phenomena are the Lombard effect (related to the vocal output level) and the cocktail party effect (related to the listening ability).

Lombard effect

The "Lombard effect" is as human reflex related to changes of the characteristics of speech due to a noisy background, in particular in terms of an increase of the vocal intensity, the fundamental frequency, and the word duration [2]. The mentioned increase of the voice loudness helps to improve the signal to noise ratio when steady state background noise is coming from sound sources such as ventilators or traffic noise. However, in case of a so called "multi-talker" environment, the situation becomes more complicated, since a positive feedback loop can arise. As soon as a first speaker is increasing his or her voice level, with the aim of increasing the signal to noise ratio, the background noise level for the other people present in the room will be increased. Consequently these people increase the level of their voices as well in order to restore their signal to noise ratio. Consequently, the initial gain of the signal to noise ratio for the first person is neutralized.

Cocktail party effect

The cocktail party effect is a human's ability to follow and understand the speech in a multisource (multi-talker) environment [3]. It is has been proven that this is possible only thanks to binaural aspect of hearing, very much correlated with human ability to localize sound [4]. This effect is therefore in the literature often addressed as „sound source determination'' or ''sound source segregation". So a "cocktail party effect" doesn't have a direct impact on noise in place.

Experiments

Measurements of the reverberation time and the noise levels versus time have been performed in two eating establishments, both situated in Belgium: the Trappistencafé is a restaurant-café in the famous beer resort Westmalle, and a student restaurant-cantine in Leuven called Alma. $L_{eq,A}$ measurements were performed by using a sound pressure level meter with the measuring interval set to 1 second. The periods over which the data were collected were typically 15 minutes, unless the number of people in the room changed.

In what follows, only the number of people present in the room is reported, and thus not a number of people that are speaking simultaneously. It can be expected though that the variations of both numbers are strongly correlated.

Trappistencafe, Westmalle

The Trappistencafé is situated in the city of Westmalle, in the north of Belgium and it is a very popular place often visited by local people as well as by visitors of the Westmalle abbey. During peak hours it becomes often completely full and noisy. The volume of the room is 1092 m^3 and the user's floor area around 300 m^2. The capacity of the place is around 180 people, so that the mean floor area per person is 1.66 m^2. The customers' area is visually divided into 2 parts, without acoustical barrier in between. The height of the ceiling in the room is on average 3 m. The room is furnished by wooden chairs, tables without tablecloth, the floor consists of stone tiles and the ceiling is partially made out of perforated gypsum boards.

The reverberation time of 0.8 s in this room has been derived from impulse responses measured for 2 loudspeaker and 8 microphone positions in the presence of 10 people. Measurements of noise levels have been performed between 16:00h and 24:00h, while tracking the number of people present.

Figure 1: Interior in the Trappistencafé Westmalle

Alma, Leuven

Alma is one of the most popular student restaurants at the K.U. Leuven, which is typically open during the lunch and dinner times. Alma is much larger place than Trappistencafé, but it has similar value of floor area per person, i.e. 1.7 m^2. The capacity of the room is approximately 660 persons. The place has an absorptive ceiling and a thin carpet on the floor in the parts where people have their meal. The measured *RT* in this room varies between 1.0 s and 1.5 s.

Figure 2: Interior in the student restaurant Alma

Results and Discussion

The results of both experiments are depicted and compared in Figure 3. The data are presented together with trend lines that indicate the slope according to which the sound pressure level grows with number of people. For the data from Westmalle (black squares), a sound pressure level increases with 5 dB per doubling of the number of people. The sound levels measured when less people were present in the rooms are slightly higher in the Trappistencafé than in Alma. This is probably due to the presence of radio sound, which made people increase their voice more than in case of Alma restaurant, where no background music was played.

For the Alma restaurant, the slope is slightly steeper, i.e. a bit more than 6 dB per doubling of the number of people. With the number of people present reaching a value for full occupation, the standard deviation gets larger and some measured values lie much higher then one would expect, even by taking in to account the Lombard effect.

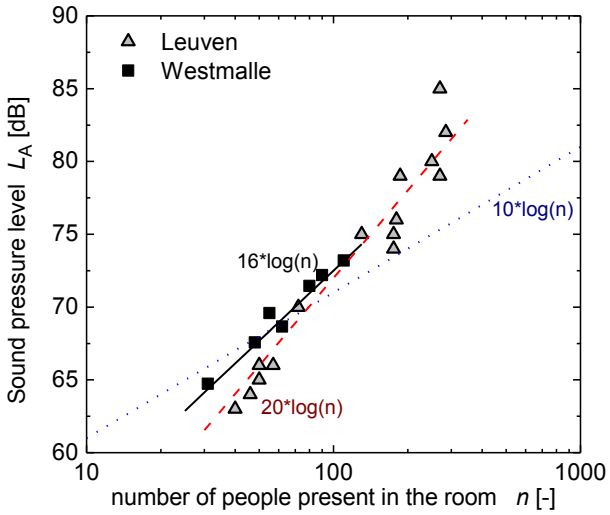

Figure 3: Sound pressure level in the restaurant as a function of the number of people present. The dotted line in the chart corresponds to the expected increase in sound level with the Lombard effect not taken into account, i.e. to a slope of 3dB per doubling of the number of people (incoherent sound sources).

The occurrence of such high levels could be explained as follows. For moderate noise levels, only one out of four people at a table is talking to the other people around.

However, if the noise level increases so much, that the conversation can be heard only within very short radius from a speaking person, then groups of people might split in smaller groups and talk only with a nearest neighbour. This hypothesis must be however confirmed as well and more acoustical experiments combined with questionnaires about the human experience need to be performed.

References

[1] Rindel, J. (2010): Verbal communication and noise in eating establishments, Applied Acoustics 71, 1156-1161

[2] Lombard, E. (1911): Le signe de l'élévation de la voix. Annales des maladies de l'oreille et du larynx 37, 101–119.

[3] Cherry, C. (1953): Cocktail Party problem, Journal of Acoustical Society of America 25, 975-979.

[4] Rychtarikova, M., Van den Bogaert, T., Vermeir, G., Wouters, J. (2011): Perceptual Validation of Virtual Room Acoustics: Localization and Speech Understanding, Applied Acoustics 72, 196-204.

[5] Nijs, L., Saher, K., Den Ouden, D. (2008): Effect of room absorption on human vocal output in multitalker situations, Journal of Acoustical Society of America 123, 803-813.

[5] Astolfi, A, Filippi, M. (2004): Good Acoustical Quality in Restaurants: a Compromise Between Speech Intelligibility and Privacy, in Proc. of ICA 2004, Kyoto, Japan.