Acutical measurement and questionnaire survey on the comfortableness of conversation in tavern

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Abstract. In the spaces such as taverns and cafes, there are more than one group in a space, and each group is conversing within the group. These spaces are defined as “multi-group conversation spaces (MGCS)”. The purpose of this study is to find the optimal acoustic environment in taverns as an example of MGCS regarding with the comfortableness of conversation. For this purpose, acoustic measurement and questionnaire survey were conducted in two types of taverns, semi-separated room type and mono-space type. In the acoustic measurement, unoccupied room impulse responses and sound pressure levels in the operating time were measured. In the questionnaire survey, questions of subjective evaluations such as ease of conversation and importance of speech privacy were asked to guests. As a result, the noise level of mono space type in the busy time was 76-77 dB and higher than that of semi-separated room type (69-73 dB), and this difference seemed to be caused by the higher level of background music in the mono space type. The result of questionnaire survey showed that guests of semi-separated room type answered higher importance of privacy in tavern than those in the mono space type. It is also suggested that importance of privacy might affect client’s preference of the type of tavern.

1. Introduction
In the spaces such as taverns and cafes, there are more than one group in a space, and each group is conversing within the group. In our previous study, these spaces were defined as “multi-group conversation spaces (MGCS)”. Optimum acoustics environments and acoustics design has been less discussed for MGCS than spaces that require speech privacy such as hospitals or pharmacies. It is assumed that there are many factors to be evaluated for acoustics in MGCS, such as: comfortableness within groups, privacy between groups, liveliness, calmness, and easiness of ordering foods or drinks. It should be necessary for the acoustic design of MGCS to understand the relationship between these factors and acoustics characteristics.

Thus, in this study, an acoustic measurement and a questionnaire survey were conducted in two different types of tavern to investigate actual acoustic situation of tavern as a basic step.

2. Survey

2.1. Surveyed tavern
Two taverns were selected for the survey. One was semi-separated room type (T1) where tables were set up like separated rooms by partial walls of about 1.6m height. All the tables of T1 were regarded as acoustically connected. Another was mono-space type (T2) without partition. Plans of the taverns are shown in Fig. 1. The ceiling height of both taverns was about 2.6 m. Sound absorbing material were
not installed to the surfaces of both of the taverns. Only a carpet put in a part of a passage floor and two or three cushions placed at every table in T1 were regarded as sound absorptive. We divided T1 into 11 sections and T2 into 7 sections for the survey. Sections 1 and 10 in T1 can be connected by removing the panel between them and “10c” denotes the connected condition.

![Figure 1. Plans of surveyed taverns and measurement point.](image)

Table 1. Subject attribute.

| Tavern | Gender | Spacing 20-24 | Spacing 25-34 | Spacing 35-44 | Spacing 45-54 | Spacing 55- | Total |
|--------|--------|---------------|---------------|---------------|---------------|-----------|-------|
| T1     | Male   | 7             | 16            | 10            | 2             | 7         | 42    |
|        | Female | 14            | 12            | 7             | 5             | 7         | 45    |
| T2     | Male   | 12            | 15            | 6             | 11            | 3         | 47    |
|        | Female | 8             | 11            | 19            | 5             | 1         | 35    |
|        | blank  |               |               |               |               | 1         | 1     |

2.2. Reverberation time
In each of the sections, one seat was set as a source point and another one or two seats were set as receiving points assuming a conversation partner, and impulse responses were measured using time-stretched pulse.

2.3. Sound pressure level
A-weighted sound pressure level was measured at a point near the center of each of the taverns for 3 hours from just after the opening of the tavern without guests until busy period. At the same time number of guests was counted separately for two areas of near tables (1, 4, 5, 8, 9, 10 of T1, and 1, 2, 3 of T2) and far tables (others), which were divided by about 8 m from the measurement point.

2.4. Questionnaire survey
A questionnaire survey was conducted for the guests. The questionnaire sheet consisted of five questions asking impressions at the table, such as: importance of privacy regarding others’ eye and conversation voices, evaluation and preference of liveliness or calmness, easiness of conversation, kinds of distracting sounds, and two face items of age and gender. The questionnaire were handed to the guests when they made an order at the first time and collected at the first serving because it would be as difficult to request answering after drinking alcohol. At the same time, occupied tables around the respondents were recorded by the researcher to grasp how many conversing groups existed at the time of the answer. The survey was conducted on five normal days and busy two days (weekend or
holiday) for both of the taverns. In total 87 (male 42, female 45) in T1, and 83 (male 47, female 35, blank 1) in T2 (Table 1) answers were collected.

3. Results

3.1. Reverberation time
Reverberation times were calculated from the measured impulse responses. The average T30 (500-2000 Hz) in each section were 0.2 - 0.4 s in T1 and 0.4 - 0.5 s in T2 (Fig. 2). These values seemed to be short considering the volumes of each of the spaces. The reason might be that they were an elongated shape with many tables and chairs and, furthermore, T1 was separated into small sections.

Figure 2. Reverberation time of each section.

3.2. Sound pressure level

Table 2. Percentile sound pressure level of T1

| Index | 17:30-18:00 | 18:00-18:30 | 18:30-19:00 | 19:00-19:30 | 19:30-20:00 | 20:00-20:30 |
|-------|-------------|-------------|-------------|-------------|-------------|-------------|
| L₉₅  | 43.7        | 45.0        | 46.2        | 47.8        | 53.2        | 55.1        |
| L₉₀  | 44.7        | 46.2        | 47.3        | 48.9        | 54.3        | 56.1        |
| L₅₀  | 50.0        | 50.4        | 50.7        | 52.2        | 58.6        | 60.3        |
| L₅   | 54.1        | 54.2        | 54.5        | 56.9        | 65.5        | 70.1        |
| Lₐₐₐ | 55.2        | 55.3        | 55.5        | 58.7        | 69.0        | 72.7        |

Table 3. Percentile sound pressure level of T2

| Index | 18:00-18:30 | 18:30-19:00 | 19:00-19:30 | 19:30-20:00 | 20:00-20:30 | 20:30-21:00 |
|-------|-------------|-------------|-------------|-------------|-------------|-------------|
| L₉₅  | 55.7        | 54.4        | 56.8        | 58.5        | 62.9        | 64.5        |
| L₉₀  | 57.5        | 56.5        | 58.3        | 60.2        | 64.1        | 65.5        |
| L₅₀  | 61.7        | 61.3        | 63.6        | 64.3        | 68.4        | 69.9        |
| L₅   | 66.6        | 64.9        | 67.4        | 68.6        | 73.7        | 75.3        |
| Lₐₐₐ | 69.2        | 66.5        | 68.5        | 70.2        | 75.8        | 76.9        |

Figure 3. Sound pressure level of T1

Figure 4. Sound pressure level of T2
Table 2 and Table 3 show the percentile sound pressure levels (Lx), equivalent sound pressure levels (LAeq), and numbers of guests in the tavern by 30 minutes, and Figs. 3 and 4 show the time series of 1 second LAeq. The major sound sources were mostly conversation and background music (BGM).

The SPLs of the period without guest could be regarded as the background noise level. The value of each tavern was 44 - 55 dB in T1 (17:30-18:00), and 54 - 69 dB in T2 (18:00-19:00) in 90 % range of time. This difference seems to come from a higher volume of BGM in T2 than that of T1.

There were rather few guests in the near area in the first 120 minutes in both of the taverns and the LAeq didn’t change much and after that the LAeq raised by about 5 dB with the increase of guest in the near area. This result implied that the speech in far area didn’t affect the noise level at the measurement point probably because the voice level was lower than that of BGM. This also implied that speech of several meter distant from a table couldn’t be heard at the table. It is assumed that this increase of SPL was caused by conversation as the researcher observed that the volume of BGM was not raised with the increase of the guest. Moreover, it was suggested that the conversation voice level in T2 was louder than that in T1 because the LAeq in this busy period in T2 was 4-6 dB louder than that of T1 and the number of guest sat on the near chairs in T2 was 5 times less than those in T1.

3.3. Questionnaire survey
Respondents answered “very important” and “rather important” were about a half in T1 and about 23% in T2 (Fig. 5) to the question of importance of privacy. This result suggested that a preference of a guest might reflect his/her choice of a tavern. As for the evaluation of liveliness/ calmness of the tavern, the difference of evaluation between the two types clearly appears in the result, and more than half of the respondents in T1 evaluated “calm” (Fig. 6). The easiness of conversation was analysed by the number of other occupied tables at the answering time (Fig. 7). In the result T1 received better evaluation than T2 as a whole and the evaluation shifted to toward worse evaluation under the condition of three or more occupied tables. The question about distracting sounds were multiple choice questions from four kinds of sounds shown in Fig. 8. As a result, major answers were “surrounding conversation (45 %)” and nothing (41 %)” in T1 and “nothing (70 %)” and “BGM (20 %)” in T2. The result in T1 seemed to be a reflection of the preference of the respondents who put importance on the privacy. The answer to BGM in T2 was higher than that in T1 (13 %) and this is in accordance with the actual volume of BGM. Also, the high ratio “nothing” in T2 suggested a possibility that the BGM masked other sounds.
4. Conclusions
In this study, an acoustic measurements and questionnaire survey was conducted for two different types of taverns to clarify the actual condition of the acoustic environment in taverns. Major results are that the conversation level of the mono-space tavern was higher than the semi-separated room tavern probably because of the volume of the BGM and possibly affected by the longer room reverberation, and that the evaluation of importance of privacy may influence the guests’ choice of the type of tavern.

In further studies, more investigation for actual conditions of tavern is necessary and, additionally, experimental studies on easiness of conversation such as balancing speech intelligibility between the table inside and between tables would be needed.

5. References
[1] Hiraguri Y, Ueda M, Kawai K and Yano 2014 T. Fundamental investigation of easy to talk at multigroup communication space ICBEN 2014

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