Multivariate statistical analysis for acoustical characteristics of the onomatopoeic expression on tinnitus

Takahiro TAMESUE[1]

[1]Yamaguchi university, Japan, tamesue@yamaguchi-u.ac.jp

Abstract

It is difficult to measure tinnitus objectively and quantitatively. Subjective expression with onomatopoeia is adopted as one of the Japanese standard test methods used to assess tinnitus. In this test method, whether tinnitus resembles pure tone or narrow band noise, and, frequency of the pure tone and bandwidth of the noise, are determined. This study focused on the subjective expression with onomatopoeia about the tinnitus the patient complained. Techniques of multivariate statistical analysis are used for evaluation of timbre on the subjective expression with onomatopoeia about the tinnitus. Specifically, first, the Semantic Differential (SD) method with 7-point bipolar adjectival scale is employed to evaluate timbre on the subjective expression with onomatopoeia about the tinnitus. Next, 3 factors related to timbre on the subjective expression with onomatopoeia were extracted by use of factor analysis. Then, subjective expression with onomatopoeia about the tinnitus was classified by factor score.

Keywords: Onomatopoeia, Tinnitus, Semantic differential method, factor analysis

INTRODUCTION

In recent years, tinnitus retraining therapy (TRT) [1], which seeks to improve brain plasticity and adaptation to tinnitus, has received a lot of attention as a treatment based on a neurophysiological model of tinnitus. TRT is a sound therapy that aims to remove tinnitus from conscious perception. The goal of TRT is to decrease the discomfort associated with tinnitus by using constant low sound pressure levels of broad-band noise (white noise, pink noise, speech noise) to reduce the detectability of tinnitus at the subconscious level. Although the systemization of the therapeutictechniques in TRT is progressing [2], but first it is necessary to understand the acoustical characteristics of tinnitus correctly. It is difficult to measure tinnitus objectively and quantitatively. Subjective expression with onomatopoeia is adopted as one of the Japanese standard test methods used to assess tinnitus. In this test method, whether tinnitus resembles pure tone or narrow band noise, and, frequency of the pure tone and band width of the noise, are determined. This study focused on the subjective expression with onomatopoeia about the tinnitus the patient complained. Techniques of multivariate statistical analysis are used for evaluation of timbre on the subjective expression with onom atopoeia about the tinnitus. Specifically, first, the Semantic Differential (SD) method with 7-point bipolar adjectival scale is employed to evaluate timbre on the subjective expression with onomatopoeia about the tinnitus. Next, 3 factors related to timbre on the subjective expression with onomatopoeia were extracted by use of factor analysi s. Then, subjective expression with onomatopoeia about the tinnitus was classified by factor score.

OUTLINE OF PSYCHOLOGICAL EXPERIMENT

The timbre of onomatopoeia about the tinnitus the patient complained were examined using SD (Semantic Differential) method.

2.1 Participants

A total of 12 students with normal hearing participated in the psychological experiment.

Table 1. Pairs of adjectives

gentle	—	hard
distinct	—	dull
clamorous	—	quiet
deep	—	metalic
clear	—	thick
strong	—	weak
calm	—	shrill
beautiful	—	ugly
powerful	—	unsatisfactory
bright	—	dark
glossy	—	matte
rich	—	poor

Table 2. Factor loadings

Adjective pair	I	II	III
gentle — hard	-0.472	0.442	0.336
distinct — dull	0.131	0.230	**-0.640**
clamorous — quiet	**0.755**	-0.307	-0.068
deep — metalic	0.327	-0.067	**0.720**
clear — thick	-0.400	**0.725**	-0.208
strong — weak	**0.826**	-0.260	0.003
calm — shrill	-0.082	-0.144	**0.639**
beautiful — ugly	-0.312	**0.768**	-0.116
powerful — unsatisfactory	**0.801**	-0.243	0.012
bright — dark	-0.160	**0.666**	-0.360
glossy — matte	-0.021	**0.778**	-0.146
rich — poor	**0.803**	0.041	0.090
Proportion of variance explained	26.46%	22.16%	13.92%

2.2 Onomatopoeia

This study focused on the subjective expression with onomatopoeia about the tinnitus the patient complained. The 86 onomatopoeia [3] in Japanese were enployed in psychological experiment.

2.3 Procedure

The timbre of these onomatopoeia were examined using SD (Semantic Differential) method. Each onomatopoeia was presented repeatedly to the participants on the monitor until their judgments were over. The participants rated their psychological impressions of the onomatopoeia on a seven-point category scale for 12 pairs of adjectives. The pairs of adjectives were shown in Table 1.

FACTOR ANALYSIS

The data for 12 pairs of adjectives for the onomatopoeia were analyzed with the method of factor analysis. 3 factors would be extracted by the criterion that eigenvalues are more than 1 were applied. The factor loadings of the pairs of adjectives for the 3 factors are shown in Table 2. In this table, the values of factor loading with absolute values above 0.6 are shown in bold.
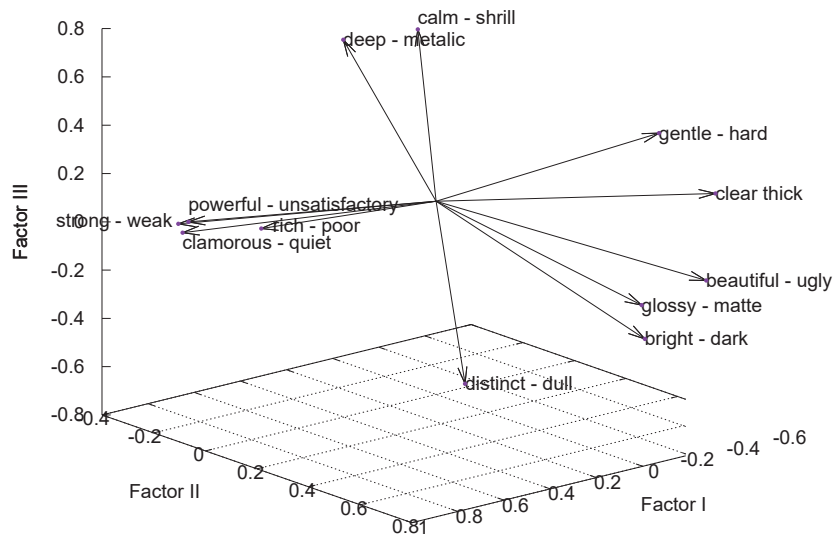
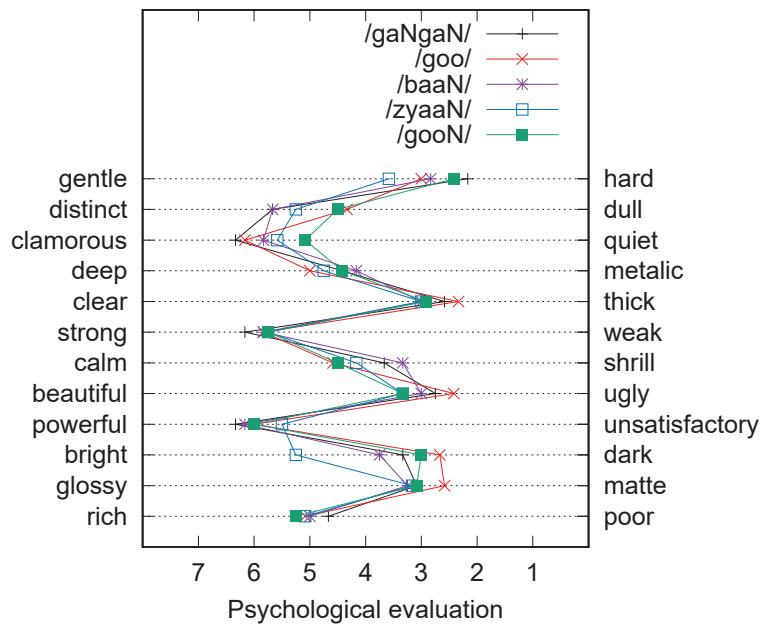Figure 1. Factor loadings for each adjective pair

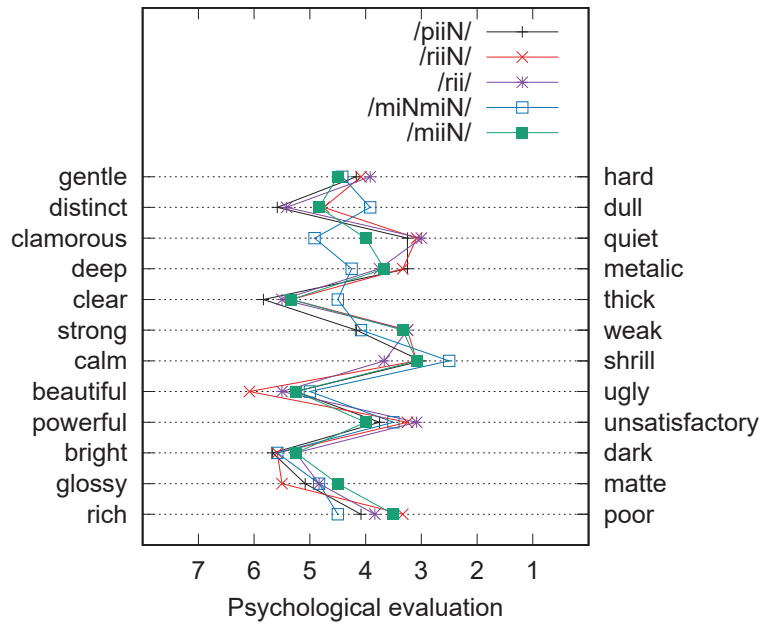Figure 2. Semantic profile of the onomatopeia related to the "poweful" factor

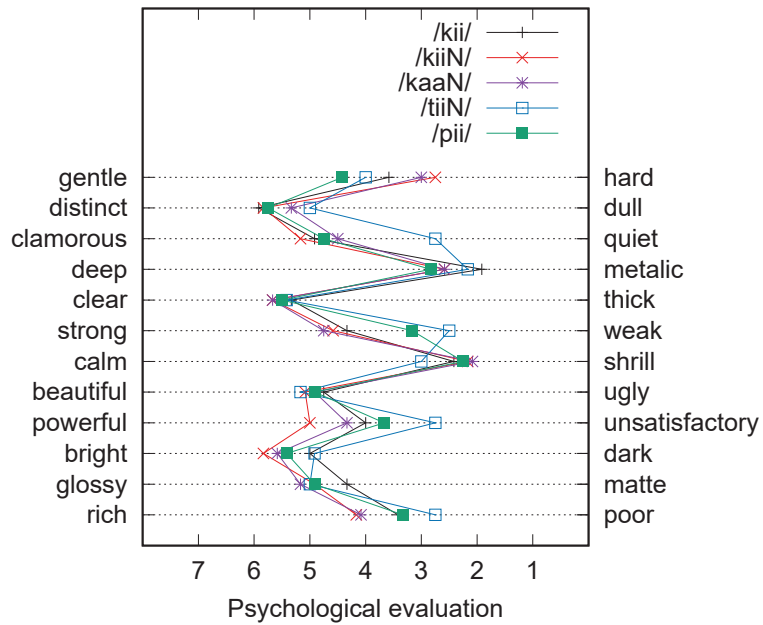Figure 3. Semantic profile of the onomatopeia related to the "beautiful" factor

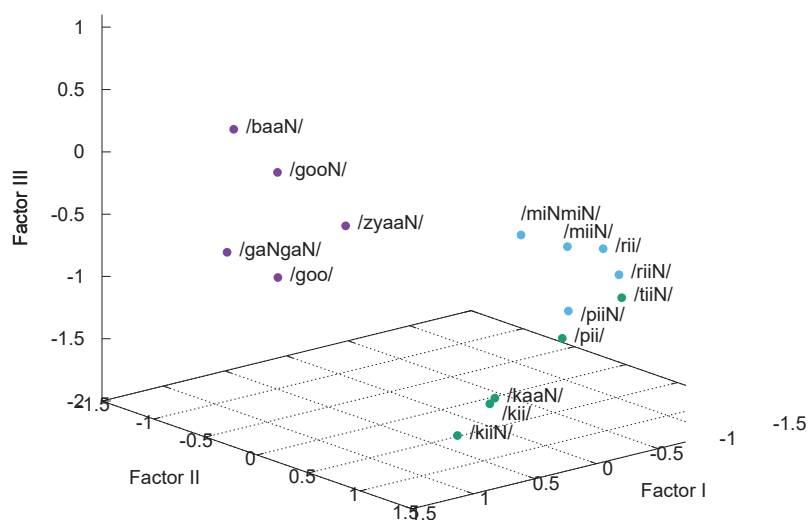Figure 4. Semantic profile of the onomatopeia related to the "metallic" factor

Figure 5. Factor scores of the onomatopeia

Factor loadings of the first factor, Factor 1, have larger loadings in the case of adjective "clamorous — quiet", "strong — weak", "powerful — unsatisfactory" and "rich — poor". Factor I can be interpreted as "powerful" factor. Factor 2 shows high loadings for "clear — thick", "beautiful — ugly", "bright — dark" and "glossy — matte" and can be interpretedas "beautiful" factor. Factor 3 shows high loadings for "distinct — dull", "deep — metalic" and "calm — shrill", and can be regarded as "metalic" factor. Furthermore, the relatiohship among 3 foctor loadings about 12 pairs of adjectives, were shown in Figure 1.

Examples of the semantic profiles for onomatopoeia related to the "powerful" factor are shown in Figure 2. It can be seen that /gaNgaN/, /goo/, /baaN/, /zyaaN/ and /gooN/ of onomatopoeia give the psychological impression "clamorous", "strong", "powerful" and "rich". Figure 3 shows examples of the semantic profiles for onomatopoeia related to the "beautiful" factor. It can be seen that /piiN/, /riiN/, /rii/, /miNmiN/ and /miiN/ of onomatopoeia give the psychological impression "clear", "beautiful" and "bright". In Figure 4, examples of the semantic profiles for onomatopoeia related to the "metalic" factor are shown. It can be seen that /kii/, /kiiN/, /kaaN/, /tiiN/ and /pii/ of onomatopoeia give the psychological impression "distinc", "metalic", "shrill".

Figure 5 shows the relatiohship among 3 factor scores about the abnove onomatopoeia. It was confirmed that the distribution on factor score for each category was very different.

CONCLUSIONS

In this study, the subjective expression with onomatopoeia about the tinnitus the patient complained, were adopted to the techniques of factor analysis for evaluating the timbre about the tinnitus. Result of employng the semantic Differential (SD) method with 7-point bipolar adjectival scale and factor analysis to evaluate timbre on

the subjective expression with onomatopoeia about the tinnitus, 3 factors: "powerful", "beautiful" and "metalic", were extracted. Subjective expression with onomatopoeia about the tinnitus was classified by factor score.

ACKNOWLEDGEMENTS

REFERENCES

[1] P. J. Jastreboff, Phantom auditory perception (tinnitus): mechanisms of generation and perception, Neuro-science Res. 8, 4, 221-254, 1990.

[2] P. J. Jastreboff, M. M. Jastreboff, Tinnitus retraining therapy for patients with tinnitus and decreased sound tolerance, Otolaryngol Clin North Am, 36, 321-336, 2003.

[3] H. Shinohara, K. Tawara, T. Tamesue, T. Saeki, Y. Katoh, Tone Color Analysis for the Onomatopoeia to Express Tinnitus, Proceedings of autumn meeting the Acoustical Society of Japan, 835-836, 2016.

[4] S. Namba, S. Kuwano, Method of psychological measurement for hearing research, Acoustical Society of Japan, Colona Publishing, Tokyo (Japan), 1998.