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Evaluate Impressions of Vinyl Record Audio Using a Semantic Differential Method.

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ABSTRACT

In recent years, while overall sales of CDs and other audio products have declined, sales of vinyl records have risen. One of the reasons for the popularity of vinyl records is the so-called 'vinyl record like' of vinyl records, such as warmth and nostalgia. We want to clarify people's impression of the sound quality of vinyl record. In the evaluation experiments, comparisons were made between vinyl record audio and high-resolution audio, and impression evaluation experiments were carried out using the semantic differential method. As a result of the principal component analysis of the obtained responses, it is confirmed that the first principal component consists of brightness and clarity, and the second principal component consists of beauty and power, with a cumulative contribution rate of 0.79. The results of the multiple regression analysis also show that the degree-of-freedom-adjusted coefficient of determination for "not nostalgic ⇔ nostalgic" exceeds 0.5, which means that prediction is possible with two principal components, and since the first principal component has a higher value than the second principal component, it is considered that the first principal component is mostly predictive. The diagram of principal component scores shows that the record group tends to have a strong impression of gloom and doom in the first principal component. The two points suggest that vinyl records with gloomy and dazed impressions have a nostalgic sound quality.

Keywords: Vinyl record, Semantic Differential method, Impression Evaluation

1. INTRODUCTION

In recent years, the development of information technology has made it possible to handle sound sources with large data sizes easily. Around 2013, high-resolution audio, which has a more extensive data size than the conventional CD sound source standard in terms of sampling frequency and quantization bit number, became widespread, expanding the range of people's musical experiences. On the other hand, the popularity of vinyl records, which became popular in Japan around 1940, has remained strong. Figure 1 shows overall audio sales in Japan, including CDs, vinyl records, and cassette tapes; Figure 2 shows CD sales; Figure 3 shows sales of vinyl records [1]. Figure. 1,2, and 3 show that while overall audio sales and CD sales are decreasing year by year, sales of vinyl records are increasing yearly. One of the reasons for this may be that, even though it has become possible to listen to music easily by using music distribution services without purchasing CDs, some users prefer to listen to music on vinyl records using record players, and this trend is increasing. One of the reasons for the popularity of vinyl records is that they have a warm sound and a sense of nostalgia that digital sound sources do not have. Although studies have described differences in impressions of the five-recording media CD, high-resolution audio, UHQCD, cassette tape, and vinyl record [2], it has yet to be examined whether the impression of nostalgia in vinyl record is derived from the sound quality.

Therefore, in this report, to investigate the impression of vinyl records obtained from a vinyl record and the high-resolution audio used as the comparison object are collectively called digital sound sources, and impression evaluation using the semantic differential method was carried out on them.

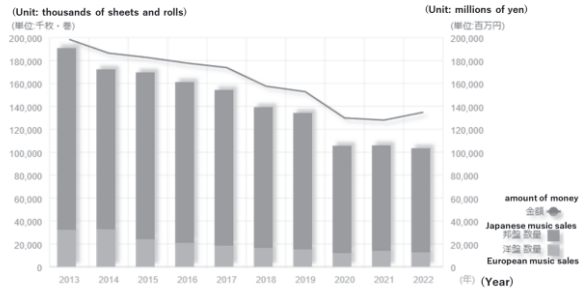

Figure 1. Overall audio record sales [1].

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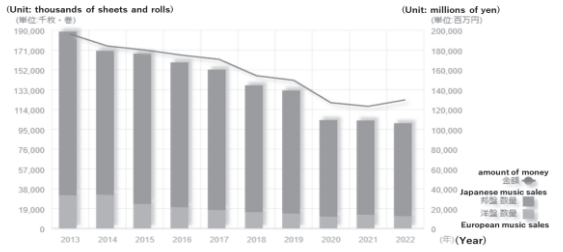

Figure 2. CD sales [1].

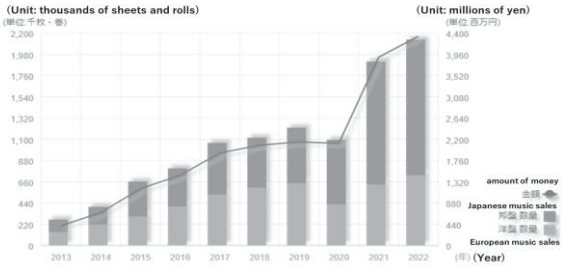

Figure 3. Vinyl record sales [1].

2. IMPRESSION EVALUATION EXPERIMENT USING A SEMANTIC DIFFERENTIAL METHOD

2.1 Methods of sound source acquisition

2.1.1 Selection of musical pieces

A list of the musical pieces used in this experiment is shown in Table 1. A total of six songs were selected for use in this experiment, two each from Anita O'Day's album 'Anita Sings The Most' released in 1957, Hiromi Ota's album 'Kokoro ga kaze wo hita hi' released in 1975, and Mili's album 'Hue' released in 2017. Note that all songs were selected at around 140 BPM to eliminate the possibility of judgments based on differences in BPM when evaluating impressions.

Table 1. Songs list.

Artist.	Title.	Music ID	
		Record audio	Hi-res audio
Hiromi Ota	Momen no hankati-fu	R_momen	H_momen
Hiromi Ota	Higurashi	R_higurashi	H_higurashi
Anita O'Day	Love me or leave me	R_love	H_love
Anita O'Day	Taking a chance	R_taking	H_taking
Mili	Excalibur	R_exc	H_exc
Mili	DK	R_dk	H_dk

2.1.2 Recording of vinyl record

A vinyl record was set in a record player (DENON, DP-29F), output as an analog signal from the RCA output terminals, captured into a PC (MSI, Prestige15) converted to a digital signal using an audio interface (Roland, Rubix22) and recorded on the PC using the music editing software 'Audacity' installed in the PC. The audio is recorded with a sampling frequency of 48 kHz and a quantization precision of 24 bits. The cable used to connect the PC and the audio interface was a USB 2.0 cable (Sanwa Supply, e87647-dg). The vinyl record audio was obtained in this way.

2.1.3 Acquiring high-resolution audio

The high-resolution sound sources were obtained from the music distribution service 'mora', using the same tracks as in 2.1.2 with a sampling frequency of 192 kHz and a quantization precision of 24 bits. Remastered versions from Vinyl recordings were used for the high-resolution audio of Anita O'Day's and Hiromi Ota's tracks.

2.2 Experimental stimuli and presentation method

In the experiment, participants listened to stimuli A and B of the same piece of music in turn and were asked to respond to their impression of stimulus B compared to stimulus A. The reason for comparing the two sound sources was that it was difficult to understand the difference in impression due to the difference in format when each sound source was listened to alone, and there was a possibility that only the difference in impression was due to the difference in the music piece would be reflected. The evaluation was carried out in 12 ways, with stimulus A being vinyl record audio and stimulus B being high-resolution audio, and vice versa. At this time. vinyl record audio and high-resolution audio from 2.1.2 and 2.2.3 were used as the experimental stimuli. The sound sources used were WAVE files with a sampling frequency of 48 kHz and a quantization bit of 24 bits for the vinyl record audio and 192 kHz and 24 bits for the high-resolution audio. One phrase was extracted from this sound source from the song's beginning.

2.3 Rating scale

In this report, a seven-point bipolar rating scale and 18 pairs of rating words were used for the evaluation. Table 2 shows the evaluation words. This rating scale was developed with reference to studies evaluating sound impressions, such as [2,3].

Table 2. Evaluation words.

be dazed	⇔	distinctly
gloomy	⇔	bright
soft	⇔	strict
smoke	⇔	shine
filth	⇔	pure
blunt	⇔	sharp
plain	⇔	flowery
slackness	⇔	tension
dismal	⇔	cheerfulness
cold	⇔	warm
gritty	⇔	smooth
low-class	⇔	high-class
calm	⇔	enthusiasm
ugly	⇔	beautiful
scantiness	⇔	wealth
shallow	⇔	deep
un comfortable	⇔	comfortable
not nostalgic	⇔	nostalgic

2.4 Participants and experimental procedure

A total of 11 participants (average: 23 years old), comprised of eight students enrolled at Kunitachi College of Music or Kunitachi College of Music Graduate School, two graduates of Kunitachi College of Music, and one graduate of another university, were included in this experiment. The list of participants in the experiment is shown in Table 3. One graduate from another university verbally confirmed that he or she had equal or greater musical experience than the Kunitachi College of Music students. Participants took part in the online experiment on their computer or smartphone. First, participants were asked to confirm their consent to the experiment and enter their information. Participants entered their answers using Google Forms, an internet-based entry service.

Next, the playback volume was tested, and participants were asked to adjust the volume to a comfortable level. The participants were instructed not to change the volume after this. When listening to the experimental stimuli, participants were instructed to use earphones or headphones to hear subtle changes in timbre. The equipment used is shown in Table 3.

Table 3. Experimental participants.

No.	Age.	Equipment used
S01	24	SONY WI-C310
S02	20	DAISO True Wireless Earphone
S03	20	AirPods Pro 1st generation
S04	31	YYK-Q80
S05	23	Air Pods 3rd generation
S06	22	SENNHEISER CX PlusTrue Wireless SE
S07	23	Earphones included with Apple products
S08	21	SONY WH-H800
S09	23	Anker sound core Life P3
S10	25	WH 1000XM4
S11	25	final E-3000

3. RESULTS

The results of the principal component analysis were obtained using the responses to 16 of the 18 pairs of evaluation terms, excluding the two evaluation terms 'uncomfortable ⇔ comfortable' and 'not nostalgic ⇔ nostalgic'. For the two evaluation terms excluded in the principal component analysis, multiple regression analysis was conducted with these as the objective variables and the principal component scores obtained in the principal component analysis as explanatory variables.

3.1 Principal component analysis results

The results of the principal component analysis up to the second principal component are shown in Table 4. Table 4 shows that the cumulative contribution ratio is 0.79.

Table 4. Results of principal component analysis.

	Evaluation words	PC1	PC2
PC1 Brightness and Clarity	be dazed ⇔ distinctly	-0.43	0.06
	gloomy ⇔ bright	-0.38	-0.05
	soft ⇔ strict	-0.35	0.29
	smoke ⇔ shine	-0.34	-0.17
	filth ⇔ pure	-0.32	-0.12
	blunt ⇔ sharp	-0.31	0.10
	plain ⇔ flowery	-0.30	0.04
	slackness ⇔ tension	-0.26	-0.11
	dismal ⇔ cheerfulness	-0.20	0.14
	cold ⇔ warm	0.14	0.10
PC2 Beauty amd Power	gritty ⇔ smoothl	-0.02	-0.65
	low-class ⇔ high-class	0.01	-0.46
	calm ⇔ enthusiasm	0.01	-0.26
	ugly ⇔ beautiful	-0.16	-0.23
	scantiness ⇔ wealth	0.00	-0.20
	shallow ⇔ deep	0.03	-0.15
Standard deviation		2.51	1.10
Proportion of Variance		0.66	0.13
Cumulative Proportion		0.66	0.79

3.2 Principal component scores

Figure 4 shows the principal component scores for each experimental stimulus's first and second principal components.

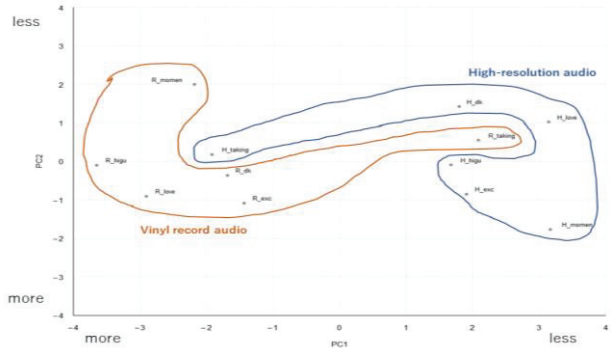

Figure 4. Principal component score.

3.3 Multiple regression analysis

The results of multiple regression analysis with the two evaluation terms excluded from the principal component analysis as objective variables and the principal component scores obtained in the principal component analysis as explanatory variables are presented. Table 5 shows the partial regression coefficients for PC1 and PC2 obtained when each evaluation term is used as the objective variable and their degree-of-freedom adjusted coefficients of determination.

Table 5. Results of multiple regression analysis.

	Partial regression coefficient.		adjusted coefficient of determination
	PC1	PC2	
un comfortable ⇔ comfortable	-0.10	-0.27	0.48
not nostalgic ⇔ nostalgic	0.25	-0.05	0.55

4. DISCUSSION

Table 4 shows that the cumulative contribution of the two principal components is 0.79, suggesting that the impression of digital sound sources can be explained by the two principal components, and in particular, the contribution of the first principal component is 0.66, suggesting that the first principal component can explain most of the impression. As for the names of the principal components, it was confirmed from Table 4 that 'gloomy' and 'be dazed' were the characteristics of the first principal component based on the loadings of the evaluation words classified under the first principal component. They were named as the principal components related to brightness and clarity. In contrast, the second principal component was named. From the loadings of the evaluation words classified into the second principal component, it was confirmed that 'gritty' and 'low-class' were characteristics of the second principal component. These were named the principal components relating to beauty and power.

Next, Table 5 shows that among the results of the multiple regression analysis, the value of the degree-of-freedom-adjusted coefficient of determination exceeded 0.5 for "not nostalgic ⇔ nostalgic", suggesting that "not nostalgic ⇔ nostalgic" can be predicted by the two principal components. The first principal component has a higher value than the second principal component, suggesting that the first principal component can predict most of the responses. From these results, it is considered that the evaluation terms "not nostalgic ⇔ nostalgic" can be explained by the first and second principal components, with the first principal component being particularly important in the evaluation of digital sound sources.

Figure 4 shows that the vinyl record group tended to have a stronger impression of darkness and vagueness in the first principal component when compared with the high-resolution audio group.

These results suggest that nostalgia is dark and dazed and that the impression of vinyl recordings is dark and dazed, and from these two points, it is suggested that vinyl recordings with dark and dazed impressions have a nostalgic sound quality.

5. CONCLUSIONS

In this report, the impressions of record sound sources were investigated. An impression evaluation experiment using the SD method was conducted on the impression of digital sound sources, and the results were analyzed using principal component analysis. As a result, the first principal components related to brightness and clarity and the second principal components related to beauty and power were identified. The contribution rate of the first principal component was 0.66, and the cumulative contribution rate up to the second principal component was 0.79, suggesting that the two principal components can explain the results, especially that the first principal component can explain most of the results. Next, a multiple regression analysis was conducted, and the results showed that the degree-of-freedom-adjusted coefficient of determination exceeded 0.5 for "not nostalgic ⇔ nostalgic" and that the first principal component had a higher value than the second principal component when each partial regression coefficient was checked, suggesting that the two principal components can explain the impression of nostalgia. The results suggest that the impression of nostalgia can be explained by two principal components, and in particular, the first principal component is considered to be largely predictable. The above results suggest that nostalgia is dark and dazed and tha the impression of vinyl recordings is dark and dazed. These two points suggest that vinyl records with dark and dazed impressions have a nostalgic sound quality.

Kubodera was in charge of planning, data collection, and manuscript writing, while Miura provided overall guidance and advice.

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