

# Appropriate background music in Japanese coffee shops assessed via autocorrelation and beats-per-minute analyses

Ryota Shimokura<sup>1</sup>

<sup>1</sup>Department of Systems Science, Graduate School of Engineering Science, Osaka University, 1-3 Machikaneyama, Toyonaka, 560-8531 Japan

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Coffee shops in Japan are often restful spaces to spend time and relax. To maintain an inviting environment, shop managers often play relaxing and tranquil background music (BGM). The author went to 20 coffee shops and identified the titles and artists of 76 songs used as BGM. The music categories were classical (26%), jazz (21%), pop (16%), rock (12%), and others (25%). A semantic differential (SD) method with 24 adjectives was used to determine an affective score for each piece of music. Ten songs were selected from the 76 BGM samples, with representation from each category, and were presented to 22 participants (11 males and 11 females) via headphones. The participants also judged the degree to which the music samples were appropriate for a coffee shop using the same scale. As a result of the factor analysis, the BGM samples from the coffee shops were rated according to 'affiliation.' To examine the physical parameters of the songs rated most appropriate for coffee shops, autocorrelation function (ACF) and beats-per-minute (BPM) analyses were carried out for the 10 music samples. As a result, the first maximum peak of the ACF ( $\phi_1$ ) was highly correlated with the degree to which songs were considered to be appropriate for a coffee shop ( $r = 0.68$ ,  $p < 0.01$ ), and the multiple regression analysis demonstrated that the BPM was the second most influential factor.

**Keywords:** coffee shop, background music, semantic differential (SD) method, autocorrelation function (ACF), first maximum peak of ACF ( $\phi_1$ ), beats-per-minute

## 1 INTRODUCTION

Background music (BGM) refers to music that is not intended to be a primary focus of listening. Although the aims of playing BGM in service environments vary according to the business type, the roles of BGM generally include: 1) leading behavior, 2) creating an atmosphere, and 3) masking noise. Mehrabian and Russell suggested that environmental stimuli (e.g., BGM and visual information) induce emotional responses (e.g., pleasure and arousal) that lead behaviors (e.g., spending time and money) [1]. Although previous studies have supported the effects of BGM [2-3], the factors implicated in the three main roles of BGM have not been discerned. Most experiments examining the effects of BGM in service environments were conducted in supermarkets or restaurants, and these studies reported that increasing the loudness and tempo of the BGM enhanced consumer motivation to buy or consume products (reviewed in [4]). In restaurants, a cross-modal association has been found between BGM and the perceived flavor of taste [5-7]. Examples of the effects of BGM include the observation that classical music increased total spending on restaurant food [5], music performed by a brass band was consistently matched with images of milk flavored with lemon and vanilla [6], and participants were significantly more likely to prefer foods eaten while listening to jazz [7]. In studies about the cross-modal effects of BGM, the musical genre was often used to classify the BGM characteristics.

Although the effects of BGM have been frequently examined in restaurants, few studies have examined the effects of BGM in coffee shops. Further, all of these focused on behavior induced by BGM [8-11]. For example, lower

BGM sound volume (< 45 dB) was found to promote conversation among women [8], and the amount of eye contact, the amount of conversation, and voice volume increased when the tempo of BGM was higher [9]. Further, the type of BGM influenced the amount of time that individuals spent in a coffee shop [10], and the use of a system that enabled the selection of BGM led customers to spend more money and time in a coffee shop after a discussion between the service providers and customers [11].

While coffee shops can function as places for social interaction, they can also be restful spaces to spend time without doing anything in particular, and BGM can help to create a relaxing and tranquil atmosphere. The aim of this study was to survey the BGM used in 20 coffee shops in Matsue (Shimane) and to evaluate the feeling induced by the BGM using an affective scale. Shimane has a rich coffee culture, and many original coffee shops under small-scale management were found in the city center. According to the semantic differential (SD) method, affective scores were determined using a five-point scale with 24 adjective items (e.g., tender, strong, melancholy, etc.) to express the impression of the music [12]. These 24 items were taken from a prior study [12] in which 183 Japanese participants evaluated 50 adjectives, selected according to examples from previous studies [13, 14], to determine which terms were most strongly correlated with musical impressions. In the present study, the participants in the psychoacoustic experiment reported their impressions of BGM according to the 24 adjective items, and judged the quality of BGM heard in a coffee shop using the same five-point scale.

In addition to the psychoacoustic experiment, an au-

tocorrelation function (ACF) analysis was conducted to capture the physical characteristics of BGM. The factors extracted from the ACF analysis included the pitch, tempo, clarity of the melody, and so on (see *Section 2-3-1*) [15-18]. These ACF factors were highly correlated with subjective preference for auditory signals (reviewed in [15]) and subjective annoyance induced by auditory signals [16, 17]. In addition, the ACF factors were used to extract the characteristics of various genres of music (classical, jazz, and Japanese pop), and played a role in determining the optimal headphone listening volume [18]. For these reasons, the author felt it appropriate to examine the associations between the ACF analysis and SD results.

In previous BGM studies, the sound volume and tempo (beats per minute: BPM) have often been used to describe the characteristics of musical stimuli [4, 8-11]. Because the study aim was to evaluate qualitative impressions of musical motifs, only the BPM was measured as a physical factor of the BGM stimuli. The goal of this analysis was to use the ACF factors and BPM to explain the fit of BGM to coffee shops and to propose appropriate BGM according to the physical factors of the music.

## 2 METHODS

### 2.1 Survey of background music in coffee shops

From October to November 2016, 20 coffee shops in Matsue (including major coffee chains) were visited and a total of 76 instances of songs played as BGM were recorded at positions close to the loudspeakers. The recording device was a binaural microphone (type 4101, Brüel & Kjaer). The titles and artists of the 76 songs were identified using the SHAZAM music recognition app in Android [19]. The musical genres were determined using the categories in iTunes (Apple Inc.) [20].

### 2.2 Psychoacoustic Experiment

#### 2.2.1 Musical stimuli

Of the 76 BGM songs surveyed, 10 tracks were bought and downloaded, with a roughly equal distribution of songs from the different categories (three jazz, three classical, three rock, and one pop composition). The SD method was then carried out to determine an affective score for each of the 10 songs [12]. For purposes of comparison with the 10 BGM songs, five songs used as BGM by mass retailers were also downloaded. The mass retailers were 1) LAMU (supermarket), 2) YAMADA DENKI Co., LTD. (consumer electronics retailer), 3) HARD-OFF (recycle store), 4) Don Quixote (discount store), and 5) MISHI-MAYA (supermarket). For the 15 chosen compositions, representative sections of each song (20 s) were selected as short music intervals.

#### 2.2.2 Participants and procedures

The short music intervals were presented to both ears of 22 participants (11 men and 11 women aged 21 - 39 years old) via headphones (HD 595, SENNHEISER) in a silent room (background noise was below 30 dB). Although the

music intervals taken from the downloaded songs were stereo sources, they did not give elicit spatial perception. The 22 participants went to coffee shops a minimum of twice a week. The output level of the headphones (equivalent continuous A-weighted sound pressure level) was 70 dB. The output level was calibrated using a binaural microphone (type 4101, Brüel & Kjaer) positioned at the author's ears. The order of music stimulus presentation was randomized.

The participants completed a questionnaire (24 items on a five-point scale) after listening to each 20-s clip of the BGM stimuli. For each of the 24 items, the participant was asked to rate specific adjectives in terms of how well they described the song. There was a 25<sup>th</sup> item in which participants were asked to rate the degree to which they felt the song would be an appropriate fit for a coffee shop. Visual stimuli (e.g., the view in a coffee shop) have been found to amplify pleasantness ratings when presented with an auditory cue (e.g., background noise) [21]. To exclude the possible effects of visual stimuli, the participants sat in front of a table and were directed to look at a uniform beige wall during the experiment. They were then instructed to imagine being in a coffee shop.

#### 2.2.3 Statistical Analysis

Based on the responses from the SD process, principal component analysis (PCA) was conducted to identify the minimum number of factors that influenced the participant impressions of the musical stimuli. In this study, factors with Eigen values larger than 1 were regarded as principal components. After determining the number of factors, a factor analysis was conducted to classify the 24 adjective items into the factor groups. Then, a factor load for each item and contribution rate for each affective factor were calculated. To maximize the variance of the squared loads, varimax rotation was used to control the axes of the common factors.

The differences in obtained scores were verified using an analysis of variance (ANOVA). When a difference was accepted statistically, the differences in the group were verified using the multiple comparison method (Ryan's method).

### 2.3 Physical factor of BGM

#### 2.3.1 Autocorrelation analysis

In the next step, the ACF and BPM analyzer were used to extract physical factors that could explain why particular songs were a better fit for coffee shops. The ACF is the correlation of a signal with a delayed copy of itself as a function of the delay, and is a mathematical tool for finding repeating patterns, such as the presence of a periodic signal, or identifying a missing fundamental frequency in a signal according to its harmonic frequencies. The normalized ACF of a signal  $P(t)$  is defined by

$$\phi(\tau) = \frac{\Phi(\tau)}{\Phi(0)} \quad (1)$$

where

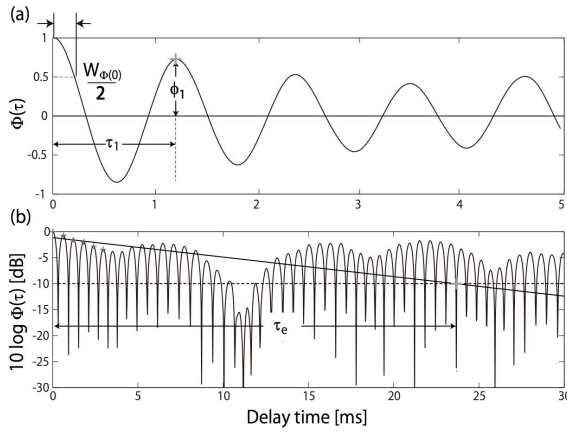


Figure 1: (a) Definitions of  $\tau_1$ ,  $\phi_1$ , and  $W_{\Phi(0)}$  in the autocorrelation ( $\Phi(\tau)$ ) and (b)  $\tau_e$  in logarithmic autocorrelation ( $10 \log \Phi(\tau)$ ). The calculated signal was "Moving Up" (Jazz1).

$$\Phi(\tau) = \frac{1}{2T} \int_{-T}^T P'(t)P'(t + \tau)dt \quad (2)$$

and where  $2T$  is the integral interval,  $\tau$  is the time delay, and  $P'(t)$  is the signal after passing through the A-weighting filter. Because ACF factors in music vary as a function of time, they were calculated in the integral interval ( $2T$ ) that moves throughout the duration of the music. In this study, the running ACF was calculated using a  $2T$  of 0.5 s, with 0.1 s sliding steps. These values were the same as those in a previous study that examined ACF factors in music of various genres [18].

From the normalized ACF, the following factors were extracted, as shown in Figure 1.

1. The delay time of the maximum peak ( $\tau_1$ ): comprehensive pitch in music
2. The amplitude of the first maximum peak ( $\phi_1$ ): clarity of melody
3. The effective duration ( $\tau_e$ ): tempo, different playing styles (e.g., legato and pizzicato), or the number of musical instruments
4. The width of the peak at  $\tau = 0$  ( $W_{\Phi(0)}$ ): the spectral center of the music

The  $\tau_e$  was defined by the delay time at which the envelope along the early decay of the normalized logarithmic ACF became -10 dB (Figure 1b).  $W_{\Phi(0)}$  was defined by doubling the delay time at which the normalized ACF became 0.5 (Figure 1a). As a result of running the ACF along the music interval (20 s), 200 values of each factor could be obtained. Thus, the represented value for a song was determined by the median value because the  $\tau_e$  value was prolonged dramatically when only pure harmonics were included in the integral interval ( $2T$ ) [18].

### 2.3.2 Beat Analysis

In addition to these ACF factors, BPM was calculated using a program in a *Matlab* [22]. The program extracts the envelope of a waveform from an inputted piece of music, and calculates the ACF after determining the weight of a Gaussian function to detect the basic periodicity. The tempo period strength is given by

$$TPS(\tau) = W(\tau) \sum_t O(t)O(t - \tau) \quad (3)$$

where

$$W(\tau) = \exp -\frac{1}{2} \left( \frac{\log_2 \tau / \tau_0}{\sigma_\tau} \right)^2 \quad (4)$$

where  $O(t)$  is the onset strength envelope,  $\tau_0$  is the center of the tempo period bias, and  $\sigma_\tau$  controls the width of the weighting curve. The  $\tau_0$  and  $\sigma_\tau$  are set at 0.55 s and 0.9 of an octave, respectively, because this numerical combination ensured consistency with the results of subjective tapping tests. The primary tempo period was the  $\tau$  for which the  $TPS(\tau)$  was the largest.

### 2.3.3 Statistical Analysis

To verify which physical factors influenced the suitability of BGM for coffee shops, a multiple regression analysis was conducted using scores reflecting the BGM fit for coffee shops as an objective variable after standardizing the scores and physical factors. A stepwise forward method was used to determine the most suitable regression model. The criterion used to judge the suitability was an adjusted coefficient of determination.

## 3 RESULTS

### 3.1 BGM in coffee shops

Table 1 shows the list of the 76 BGM songs in the 20 shops. Table 1 was put on the last page because of an editing reason. Many coffee shops used BGM in a single category to create a uniform atmosphere. For example, Starbucks and Café Blanc used music in the classical and jazz categories, respectively. Of the 76 BGM songs, 20 were classical (26%), 16 were jazz (21%), 12 were pop (16%), 9 were rock (12%), and 19 songs were in other categories (25%).

#### 3.1.1 Affective scores and fitting scores for coffee shops

The obtained affective scores and fit judgment scores were averaged for the BGM stimuli from the 10 coffee shops and five mass retailers (Figure 2). The BGM stimuli are listed in Table 2. A larger value indicates that an adjective was a more applicable descriptor. The participants reported that the BGM played in the coffee shops was "bright," "tranquil," and "tender," and that the music played in the mass retailers was "bright," "cheerful," and "pop-y." Using the responses from the 22 participants, a PCA revealed six major affective factors (*eigenvalue* > 1) that were then used to categorize the 24 adjective items. Then, a factor analysis (varimax rotation) of the six factors produced significant results ( $\chi^2_{147} = 250$ ,  $p < 0.01$ ), and the factors were translated into "elevation," "stateliness," "strength," "affiliation," "depressiveness," and "lightness," according to the previous study [12]. The factor load for each item and the contribution rate for each affective factor are shown in Figure 2. While the scores for each factor varied widely

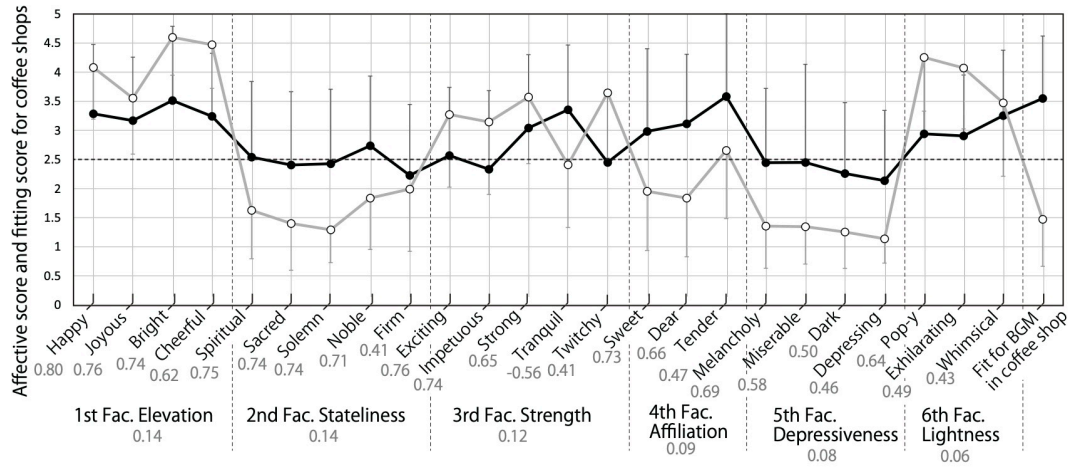


Figure 2: Affective scores for each of the 24 adjectives and the degree to which the BGM was appropriate for a coffee shop for BGM samples from 10 coffee shops (●) and five mass retailers (○) (error bar: standard deviation). The assigned numbers for each item and each affective factor (Elevation, Staleness, and so on) are the factor load and contribution rate, respectively.

Table 2: 10 BGM songs used in the psychoacoustics experiment

Jazz (3 music)	Classic (3 music)	Rock (3 music)	Pops (1 music)
Moving up (Jazz1)	Tarantelle in A-Flat Major, Op. 4 (Classic1)	Guitar Man (Rock1)	Irregular Red (Pop1)
How Long Has This Been Going On (Jazz2)	Suite for Cello Solo No.3 in C (Classic2)	Moment by Moment (Rock2)	-
Ballad of Hix Blewitt (Jazz3)	III Menuetto + Trio (Classic3)	Brown Eyed Handsome Man (Rock3)	-

for the BGM from the coffee shops, the scores were relatively consistent for the BGM from the mass retailers. This was likely because the BGM from the coffee shops included a wider range of musical genres. The scores for the affiliation factors were higher in the coffee shops' BGM.

Figure 3 shows the averaged scores for each genre and each affective factor. The scores for "tranquil" were inverted (i.e.,  $5 - score$ ) because it had a negative factor load. All combinations that were not assigned (n.s.) were confirmed to have significant differences ( $p < 0.05$ ) via Ryan's multiple comparison and an ANOVA. For example, the scores for elevation were high for the rock and pop music, as were those for staleness for the classical music, strength for the rock music, affiliation for the jazz, classical, and pop music, and lightness for the pop music. A two-way ANOVA (for genre and affective factor) revealed an effect of affective factor ( $F_{5,20} = 3.71, p < 0.05$ ), but no effect of genre, even when the BGM from the mass retailers was included ( $F_{4,20} = 0.08, p = 0.99$ ). A significant correlation was observed between the average affiliation factor scores and the scores of fit for BGM in coffee shops ( $r = 0.61, p < 0.01$ ).

Figure 4 shows the averaged scores for fit in coffee shops for each BGM sample. An ANOVA revealed significant differences between the BGM samples ( $F_{14,294} = 32, p < 0.01$ ). Because all of the combinations of BGM from coffee shops and BGM from mass retailers showed significant differences in fit, the combinations with significant differences were assigned by "\*" ( $p < 0.05$ ) only for the combinations in each group. Although the score for fit in a coffee shop was higher for jazz, as shown in Figure 3, the music sample *Jazz1* elevated the averaged score, as shown in Figure 4.

### 3.2 Physical factors

Figure 5 shows the relationships between the scores for fit in a coffee shop and the physical factors of the music samples. When the median ACF factors were examined to identify the relationships between those and the scores of fit for the BGM samples, the  $\phi_1$  value was highly correlated with the score of fit ( $r = 0.68, p < 0.05$ ), as shown in Figure 5b. Although the statistical significance was not verified, the BPM was highly negatively correlated with the score of fit ( $r = -0.55$ ), as shown in Figure 5e. The correlation coefficients among the physical factors were listed in Table 3. Except for the  $W_{\Phi(0)}$  with  $\phi_1$  and  $\tau_e$ , remarkable correlations were not observed. As a result of the multiple regression analysis (stepwise forward method), the most suitable model for estimating the standardized score of fit for a coffee shop ( $SV_{coffee\ shop\ BGM}$ ) was

$$SV_{coffee\ shop\ BGM} \approx 0.68\phi_1' \tag{5}$$

where  $\phi_1'$  refers to the standardized  $\phi_1$ . The model was statistically significant ( $F_{1,8} = 7.05, p < 0.05$ ) and the adjusted  $R^2$  was 0.402. The second most suitable model was

$$SV_{coffee\ shop\ BGM} \approx 5.47\phi_1' - 2.91BPM' \tag{6}$$

where  $BPM'$  refers to the standardized  $BPM$ . The model was not statistically significant ( $F_{2,7} = 4.01, p = 0.07$ ) and the adjusted  $R^2$  was 0.401. The  $\phi_1$  ( $r = 0.68, p < 0.05$ ) and  $BPM$  ( $r = -0.83, p < 0.01$ ) were correlated with the average scores in the affiliation factors (Sweet, Dear, and Tender).

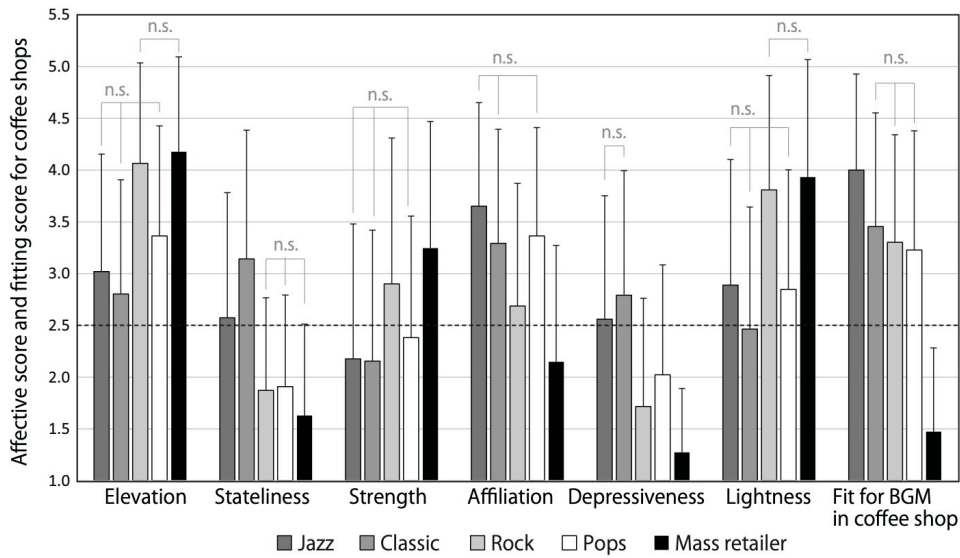


Figure 3: Average score for each affective factor and each genre (error bar: standard deviation, n.s.: not significant ( $p > 0.05$ )).

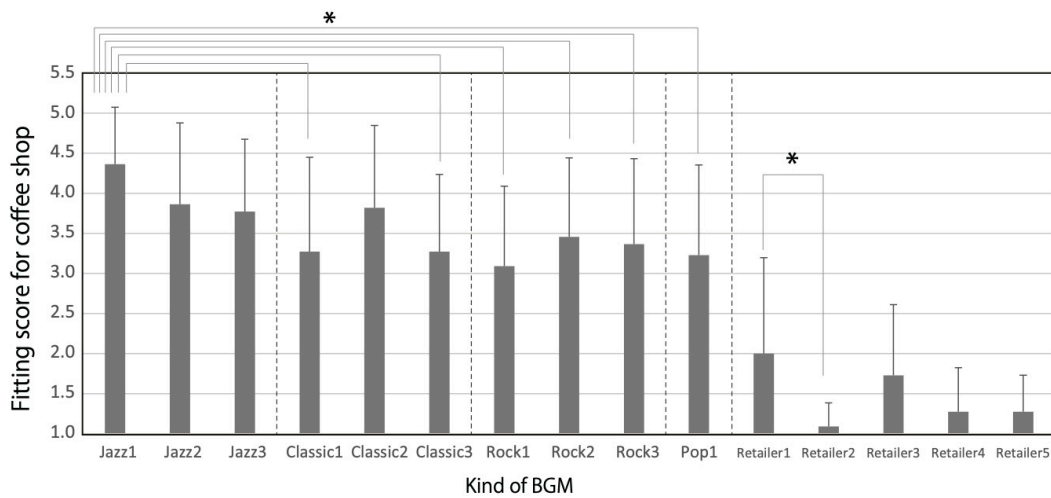


Figure 4: Scores describing the degree to which each BGM sample was considered to be appropriate for a coffee shop (error bar: standard deviation, \*: significant difference ( $p < 0.05$ )).

Table 3: Correlation matrix among the ACF factors and BPM (\*:  $p < 0.05$ )

	$\tau_1$	$\phi_1$	$\tau_c$	$W_{\Phi(0)}$	BPM
$\tau_1$		-0.38	0.25	-0.38	0.42
$\phi_1$			0.40	0.66*	-0.01
$\tau_c$				0.64*	0.25
$W_{\Phi(0)}$					0.11

## 4 DISCUSSION

### 4.1 Trends regarding BGM in coffee shops

Almost all of the surveyed coffee shops played music in a uniform genre as BGM. The purpose of this was likely to create a specific atmosphere with respect to the interior design. For example, *Café Courant d'air*, which has antique furniture and dim lighting, plays classical music, while *Café Vita*, which has American industrial furniture and leafy plants in natural sunlight, plays dance music. Because copyright protection is strictly managed by the Japanese Society for the Rights of Authors, Composers, and Publishers (JASRAC), almost all shop managers in the present study used out-of-copyright music, such as classi-

cal and jazz music, or music obtained via cable broadcast. In Japan, coffee shops where the owners play only classical music ("Meikyoku kissa" in Japanese) or only jazz music ("Jazz kissa" in Japanese) have been popular since the 1960s [23, 24]. As a result, individuals in Japan may strongly connect these types of music (classical and jazz) to coffee shops.

### 4.2 Distinct BGM-induced affect in coffee shops and mass retailers

The psycho-acoustical experiments were conducted in a silent laboratory environment. Thus, the experimental conditions were quite different acoustically from the inside of an actual coffee shop, where sounds created by tableware and speaking customers are heard together. Although such sounds could impact the affective states and behaviors of customers [25], this study focused on the affective states and physical factors extracted from the BGM itself. This was because the effects of BGM on customer behavior have already been established in actual coffee shops [8-11]. As results of the PCA, the 24 adjective items were classified



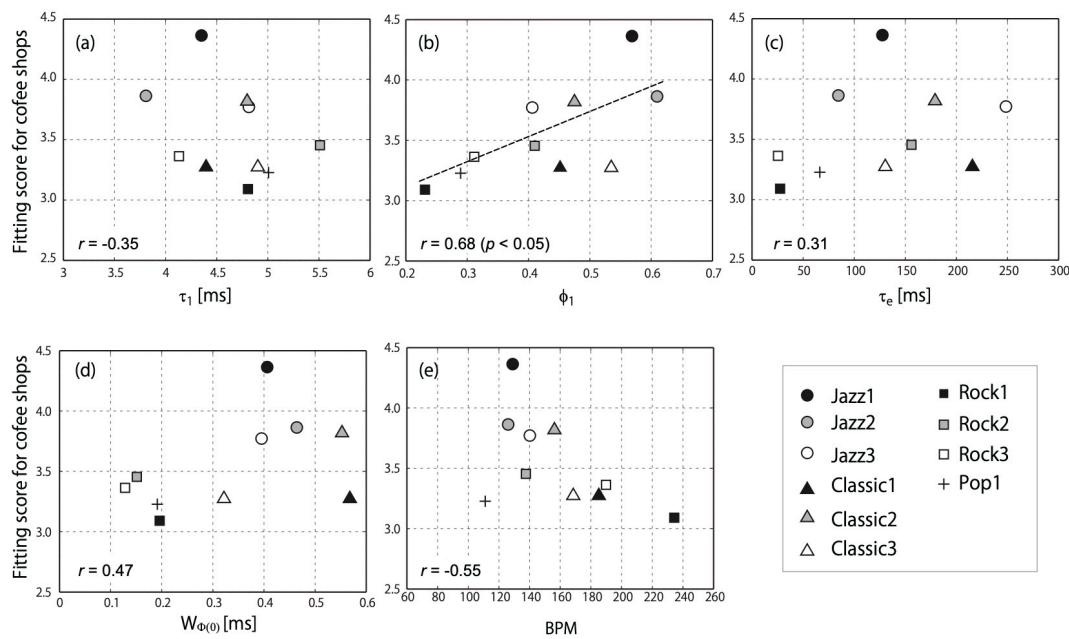


Figure 5: Score describing the degree to which each BGM sample was appropriate for a coffee shop as a function of (a)  $\tau_1$ , (b)  $\phi_1$ , (c)  $\tau_e$ , (d)  $W_{\Phi(0)}$  and (e)  $BPM$ .

into 6 factors ("elevation," "stateliness," "strength," "affiliation," "depressiveness," and "lightness"). The factor analysis in the previous study yielded 5 factors [12], while the items with negative factor loads in the elevation factor were separated into the depressiveness factor in this study. The BGM from the mass retailers had higher scores in terms of the elevation, strength, and lightness factors (Figure 3). This was likely because the purpose of this BGM was to increase arousal in the customers and to increase their desire to make purchases [26, 27]. Indeed, happy music has been found to induce happier mood in a retail setting [28, 29].

In contrast, the BGM from the coffee shops induced a characteristic increase in scores in the affiliation factor, although the scores for the elevation and lightness factors were similar to those observed for the BGM from the mass retailers. Because the average scores in the affiliation factor (Sweet, Dear, and Tender) was correlated with the scores for fit in a coffee shop ( $r = 0.61, p < 0.01$ ), affiliation may be an important factor in creating a recognizable environment in a coffee shop.

### 4.3 Effect of genre

Which genre produced an impression that was related to affiliation? As shown in Figure 3, jazz, classical, and pop music were likely to evoke affiliation; however, the effect of genre was not statistically significant. In other words, 'sweet', 'dear', and 'tender' music could exist in any genre. Although classical music has been found to increase spending on food in a restaurant compared with pop music [5], the music genre in the present study did not determine the degree to which the music seemed to 'belong' in a coffee shop. Although jazz seems to be appropriate coffee shop BGM, as shown in Figure 3, only the *Jazz1* sample elevated the averaged score, as shown in Figure 4. If the music genre influences the suitability of BGM in a coffee shop, proposed signal processing to

classify the genre [30, 31] would have been useful in this analysis. However, the degree to which a music sample was considered to be appropriate BGM for a coffee shop was related to feelings of affiliation, regardless of the music genre.

### 4.4 Physical factors defining appropriate BGM in coffee shops

What are the acoustic characteristics that generate an impression of affiliation among customers in Japanese coffee shops? Compared to elevation and lightness, affiliation is a more complex, multilateral emotion that depends on individual experience and preference [32]. Despite this complexity, the ACF analysis produced some evidence that affiliation factors are correlated with subjective preference and annoyance [15-17]. Further, the ACF calculation indicated that the amplitude of the first maximum peak ( $\phi_1$ ) was correlated with the score of fit for coffee shop BGM (Figure 5b). For complex tones, the  $\phi_1$  indicates the strength of the perceived pitch [33]. For music samples, the  $\phi_1$  indicates the clarity of the melody, and the  $\phi_1$  of vocal music decreases when the instrumental sounds are louder than the vocal sounds (melody line) [18]. Figure 6 shows the time-series  $\phi_1$  of a rock song ("Sayonara nanka wa iwasenai" by K. Inaba, used in [18]) when the vocal part and instrumental part were resynthesized to change the vocal-to-instrument (VI) ratio with respect to the sound pressure level. The VI ratio was adjusted because the vocal and instrumental sections of the song are independent. The calculation conditions were the same as those listed in Section 2-3-1. The analysis indicated that the  $\phi_1$  increased with the VI ratio. The BGM that was rated most appropriate for a coffee shop, "Moving Up" (*Jazz1*), has a clear melody that is played by a piano. In contrast, the most inappropriate BGM for a coffee shop, "Guitar Man" (*Rock1*), has a vocal part that is somewhat masked by a loud rhythmic drum sound. It is possible that enhanced accessibility

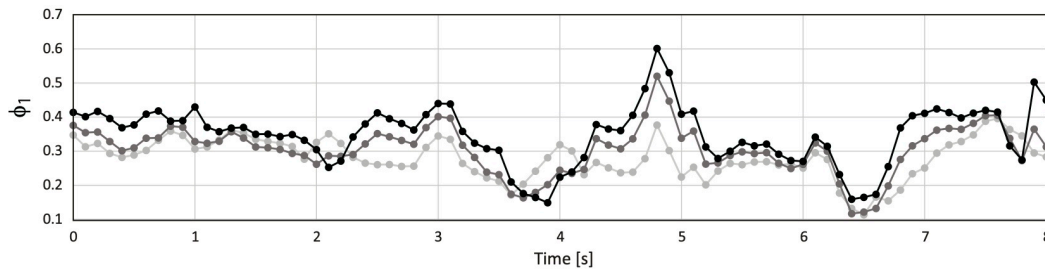


Figure 6:  $\phi_1$  as a function of time in cases in which the vocal (V) and instrument (I) balance changed in terms of the VI ratio +4 dB (●), VI ratio 0dB (■), and VI ratio -4dB (▲).

to the melody increases the degree of affiliation.

As a result of the multiple regression analysis, the BPM was the second most influential variable affecting the score of fit for a coffee shop (Equation 6). Thus, music with a slower BPM was more likely to be rated as suitable for a coffee shop. Since the preferred tempo for BGM ranges from 70 to 110 BPM [34, 35], the tempos of the musical stimuli in the present study were higher than optimal. In supermarkets and restaurants, BGM with a slower tempo tends to be more strongly associated with leisure [36, 37]. Therefore, slower-paced BGM might induce feelings of tranquility and affinity in coffee shops. Indeed, I found that affiliation factor scores were highly correlated with  $\phi_1$  ( $r = 0.68, p < 0.05$ ) and BPM ( $r = -0.83, p < 0.01$ ).

#### 4.5 Further prospects

Although the  $\phi_1$  and BPM calculated from the BGM samples played a role in the degree to which the music was perceived as appropriate for a coffee shop, the determinant coefficient of the multiple regression analysis was still low (adjusted  $R^2 = 0.401$ ). One reason for this is a lack of explanatory variables. To solve this problem, different analysis procedures for musical motifs may be necessary. Further, more than 10 musical stimuli might be necessary. For example, the scores of fit for coffee shop BGM had larger standard deviations for the *Classic1* (1.17) and *Pop1* (1.12) stimuli, indicating that the participants had different perspectives for these pieces of music. Since these stimuli were outliers with respect to each overall trend in the plots for  $\tau_c$  ("▲" in Figure 5c),  $W_{\Phi(0)}$  ("▲" in Figure 5d), and BPM ("+" in Figure 5e), it may be easier to estimate appropriate BGM for coffee shops if the parameters of the musical stimuli are more carefully controlled.

A previous study showed that music with a higher  $\phi_1$  could be heard comfortably at a smaller sound volume, even in noisy conditions [18]. Considering the three roles of BGM mentioned at the beginning of this paper, it seems that BGM with a higher  $\phi_1$  can also play a role of masking noise in coffee shops. Figure 7 compares the power spectra of the background noise measured in *Hattori Coffee in Kuroda* and the two downloaded musical sources (Table 1). The power was normalized according to the maximum values in each source, and the fast Fourier transform size was 2048 samples. The background noise (10-s recording) was obtained during the interval between two songs played as BGM, and it contained air-conditioner noise, speech sounds of customers, and tableware noise from the kitchen. As shown in Figure 7, the spectral power of the BGM was distributed in the ranges of these noises except

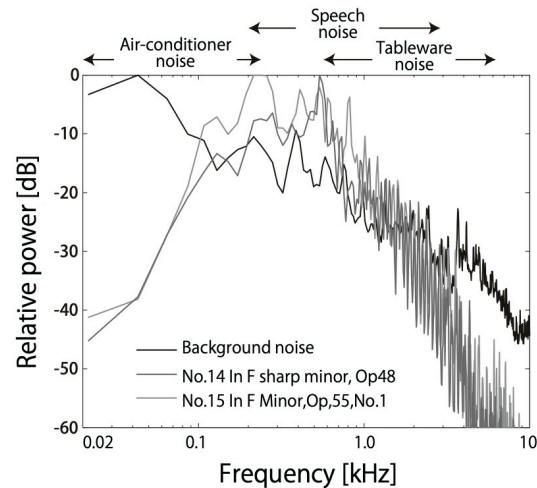


Figure 7: Relative power spectra of background noise and BGM in *Hattori Coffee in Kuroda*

for the lower range (< 100 Hz) of the air-conditioner noise and the higher range (> 4 kHz) of the tableware noise. Therefore, appropriate BGM with a higher  $\phi_1$  is expected to have a masking effect in coffee shops. In future studies, it would be helpful to examine variations in customer behavior induced by changes in the auditory environment of a coffee shop setting in terms of both background noise and BGM.

#### 5 CONCLUSION

Three approaches were employed to capture the characteristics of BGM in coffee shops: a survey of BGM in real coffee shops (real-world evaluation), the SD method (psychological findings), and the ACF and BPM analyses (physical findings). As results of the survey, classical (26%) and jazz (21%) songs were often used as BGM. As results of the SD method and factor analysis, the degree to which BGM was considered appropriate for coffee shops was related to the affiliation factor. As results of the ACF and BPM analyses, music with a higher  $\phi_1$  and lower BPM was rated as most adequate for coffee shops, indicating that customers may feel an affiliation for BGM with clearer melodies and a slower tempo.

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services.edanzgroup.com/) for editing a draft of this manuscript.

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Table 1: List of surveyed coffee shops and BGM songs

Coffee shop	Title	Artist	Category
Hattori Coffee in Kawatsu	Brown-Eyed handsome Man	Buddy Holly	Rock
	Hanky Panky	Tommy James&The Shandolls	Pops
	You've Got A lovely Daughter	Mrs Brown	Rock
	Under the boardwalk	The Drifters	Pops
	Baby Don't Get Hooked On Me	Mac Davis	Country
Sawai Coffee in Gakuenmae	Rythm Is A dancer	SNAP!	Dance
	Saving Forever for you	Shanice	Pops
Tullys Coffee in AEON Matsue	Deak the Halls	Times Square Crooners&Swingers	-
	It Came Upon A Midnight Clear	Candy Cane Trio	Christmas
	Sleigh Ride	Christmas Holiday Ensemble	Christmas
Starbucks Coffee in Shamine Matsue	Mozart:Piano Trio In G, K.564-2.Andante	Beaux Arts Trio et al.	Classic
	Bach:Suite,No1,G Major Prelude	Andre Segovia	Classic
	Mozart:Sonata For piano And Violin In G	Walter Klien&Arthur Grumiaux	Classic
	Bach:Suite For Cello solo No.3 In C	Pepe Romero	Classic
Doutor Coffee in Shamine Matsue	Fox On the Run	Manfred Mann	Rock
	Happiness	Georgie Fame	Jazz
	Rosa Do Tempo	Quarteto Em Cy	Brazil
café CaurantD'air	Debussy:La fille aux cheveux de lin	Alfred Cortot	Classic
	Debussy:Minstrels	Alfred Cortot	Classic
	Chopin:Tarantella Op.43	Alfred Cortot	Classic
Labar in Tawayama	Irregular Red	The chef cooks Me	Pops
	Day of Love	Yuko Ando	Pops
	Ten Minutes After«parla»	Naruyoshi Kikuchi	Pops
	Floatin' Groove	Keishi Tanaka	Pops
	In The Suburbs	HARVARAD	Pops
café blanc	I'm Glad There Is You	Ella Fitzgerald Feat. Ellis Larkins	Jazz
	Ain't Misbehavin'	Sarah Vaughan	Jazz
	How Long Has This Been Going On	Ella Fitzgerald	Jazz
Hattori Coffee in Kuroda	If I take You Home Tonight	Diana Krall	Jazz
	Nocturne no. 13	Vladimir Ashkenazy	Classic
	No.14 In F sharp minor, Op48	Vladimir Ashkenazy	Classic
	No.15 In F Minor,Op.55,No.1	Vladimir Ashkenazy	Classic
Komeda Coffee in Gakuenmae	No.16 In E-Flat,Op.55,No2	Vladimir Ashkenazy	Classic
	Too fond samba	Monika lunges	Jazz
	Carmens Blues(Extend version)	Jai Howel et al.	Blues
	Radames Y pela	Yamandu Costa	-
	Cagayake! Girls	Platina Jazz	Animatio
Coffee-Kan in Higashi-Honmachi	Everything I've Got Belongs To You	Terra Hazelton	Jazz
	Deux Arabesquws, L.66:No1	Philippe Entremont	Classic
	Je te veux	Marina White Piano	Classic
	Op.39/Blumenlied (Flower Song)	Irina Mejoueva	Classic
	24preludes, Op.28,No15Sostenuto-DflatMajor	Vanessa Perez	Classic
Salone del Café Hattori	Turkish Rondo	Aubrey Hilliard	Classic
	Help Me Make It Through The Night	Elvis Presley	Rock
	Susan When She Tried	Elvis Presley	Rock
	Always on my mind	Elvis Presley	Rock
	Guitar man	Elvis Presley	Rock
Scarab136	Jailhouse Rock	Elvis Presley	Rock
	Moment by Moment	Ray Barbee	Rock
	Red Sunshine	Caural	Electronic
CAFÉ VITA	Level Green	Hefner	Electronic
	DENTRO DE MIM	Jazztronik	Dance
	Dentro Mi Alma (Yoruba Soul Remix)	Jazztronik	Dance
café re:lax	CANNIBAL ROCK	Jazztronik	Dance
	Goodby Heartbreak	Lighthouse Family	Pops
	Notice Me	David Archuleta	Pops
	Blue Sky(Album)	Francesca Battistelli	Inspirational
café Kubel	Favorite Song	Colbie Caillat	Pops
	Dance With Me	Earl klugh	Jazz
	Love On A Two Way Street	Grant Green	Jazz
Hattori Coffee in Plover Hall	Tears(Razao De Viva)	Duke Pearson	Jazz
	Ballad Of Hix Blewitt	Bill Evans	Jazz
	Everything Happens To Me	Thelonious Monk	Jazz
	It Could Happen To You	André George Previn	Jazz
Hattori Coffee in Tawayama	Moving Up	Wynton kelly Trio	Jazz
	I'm Beginning To See The Light	André George Previn	Jazz
	Circle Waltz	Don Friendman Trio	Jazz
Kamedayama Coffee	You Go To My Head	Tommy Flanagan Trio	Jazz
	Serenade in C Minor,K.388"Nacht	Stephen Taylor et al.	Classic
	Wind Serenades Serenade,No.12 in C-Minor	Camerate Bern	Classic
	III Menuetto+Trio	Moonwinds	Classic
Shimauta cafe	Wind Serenades Serenade,No.11 in E-flat	Camerate Bern	Classic
	Overdose Of Joy	Eugene Record	R&B/Soul
	The Last Tree	Carita Holmstrom	Pops
	A Happy New Year(Wishing You All)	Adam Dunning	Bossa Nova
I Trace Your Symbol	Pure Bathing Culture	Alternative Rock	