RUNNING HEAD: MUSICAL INFLUENCES ON FOOD PREFERENCES

Is classical music sweeter than jazz? Crossmodal influences of background music and taste/flavour on healthy and indulgent food preferences

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ABSTRACT

Store atmospheres are inherently multisensory and constitute an important driver of consumer behaviour. The research suggests that background music (as but one element of the multisensory atmosphere) can influence consumer preference and choice. However, the findings have been inconsistent as far as how background music influences people's preferences for healthy vs. indulgent foods. By considering different music genres, food types, and tastes/flavours, we aimed to disentangle the mixed results that have been reported previously. Across two experiments (including one pre-registered replication), the participants rated their preferences for each of options (healthy savoury, indulgent savoury, healthy sweet, indulgent sweet) while listening to one of four music genres (Jazz, Classical, Rock/Metal, and Hip-hop). The results of the two experiments consistently demonstrated that the effects of background music on food preferences were dependent on the interaction between music genre, food type (healthy vs. indulgent), and taste/flavour (sweet vs. savoury). Crucially, listening to Jazz and Classical music increased people's preferences for healthy savoury foods (e.g., vegetable sandwich) as compared with Rock/Metal music. Listening to Rock/Metal, Hip-hop, and Jazz music increased people's preferences for indulgent savoury foods (e.g., a beef sandwich) as compared with Classical music. Additionally, listening to Classical music increased people's preferences for both healthier (e.g., low-fat milk) and indulgent (e.g., milk chocolate) sweet foods as compared with the other music genres. The mediating role of emotions was also documented in these experiments. Specifically, positive valence mediated the relationship between music genre and sweet as well as healthier savoury foods, while the feeling of arousal mediated the relationship between music genre and indulgent savoury foods. These findings suggest that auditory atmospherics may influence consumers' food preferences. Practical implications for store managers concerning when to select and use specific types of music are made.

Keywords: Store atmospherics; Background music; Healthy foods; Music genre; (Multi-)Sensory marketing

Highlights

- The influence of background music genre on food preferences was investigated.
- Jazz/Classical (vs. Rock/Metal) music increased preferences for healthy savoury food.
- Classical music (vs. the other genres) increased the preference for sweet foods.
- Classical music (vs. the other genres) decreased the preference for indulgent savoury foods.
- Emotions mediated the role of music genre on food preference.

Introduction

Store atmospherics are multisensory and exert a significant influence over consumer evaluations and choices (Kotler, 1973; Spence, 2020b, 2021). Store atmospherics describe a space that has been designed to create a certain impression in the consumer (Kotler, 1973) and it involve multiple senses, such as vision, audition, smell, touch (e.g., temperature), and even taste (Krishna, 2012; Spence, Puccinelli, Grewal, & Roggeveen, 2014). For example, visual (e.g., ambient lighting; Biswas, Szocs, Chacko, & Wansink, 2017; Bschaden, Dörsam, Cvetko, Kalamala, & Stroebele-Benschop, 2020; Venkatesan, Wang, & Spence, 2020), auditory (e.g., background music/noise; Bravo-Moncayo, Reinoso-Carvalho, & Velasco, 2020; Spence, 2014; Sunaga, 2018; Woods et al., 2011), olfactory (ambient scents; Madzharov, Block, & Morrin, 2015; Mattila & Wirtz, 2001; Spangenberg, Sprott, Grohmann, & Tracy, 2006) and touch (e.g., ambient temperature; Heschong, 1979; Huang, Zhang, Hui, & Wyer, 2014; Motoki, Saito, Nouchi, Kawashima, & Sugiura, 2018, 2019b) cues have all been shown to influence the expectations/perception of consumers and their preferences (see Spence, 2017, for a review). Importantly, each of sensory elements interactively influences consumer preferences (Mattila & Wirtz, 2001; Motoki et al., 2019b; Spangenberg, Grohmann, & Sprott, 2005). For instance, one study has shown that consumer evaluations (e.g., intention to visit the store) are enhanced when congruent multisensory stimuli (Christmas song and matching scent) are presented in a store compared to when either Christmas song or scent is presented individually (Spangenberg et al., 2005), though multisensory enhancement effects have not always been documented (Morrin & Chebat, 2005).

Background music

Background music is a ubiquitous element of the auditory atmospheres in many venues (North & Hargreaves, 2008) which influences a wide range of consumer behaviours (see Spence, Reinoso-Carvalho, Velasco, & Wang, 2019, for a recent review). Consumers often choose, evaluate, and consume food and drink in the presence of background music (Spence, 2012; Spence & Shankar, 2010, for reviews). Background music is a particularly common feature of retail stores and restaurants (e.g., Fürst et al., in press; Milliman, 1986; Wilson, 2003; see Spence et al., 2019, for a review). A growing body of research now demonstrates how background music (or noise) affects hedonic/sensory perception of foods (Ferber & Cabanac, 1987; Kantono, Hamid, Shepherd, Yoo, Grazioli, et al., 2016; Reinoso Carvalho, Wang, Van Ee, & Spence, 2016; Stafford, Fernandes, & Agobiani, 2012; Woods et al., 2011) and food preferences and choices (Biswas, Lund, & Szocs, 2019; Caldwell & Hibbert, 1999; Fiegel, Childress, Beekman, & Seo, 2019; Fiegel, Meullenet, Harrington, Humble, & Seo, 2014; Huang, & Labroo, 2020; Kantono, Hamid, Shepherd, Yoo, Carr, et al., 2016; Peng-Li, Mathiesen, Chan, Byrne, & Wang, 2021; Reinoso-Carvalho, Dakduk, Wagemans, & Spence, 2019).

One line of empirical research has highlighted how the ethnic congruence of music and food (e.g., Spanish music and Spanish food) influences food choices (e.g., North, Hargreaves, & McKendrick, 1997, 1999; North, Sheridan, & Areni, 2016; Peng-Li, Chan, Byrne, & Wang, 2020; Zellner, Geller, Lyons, Pyper, & Riaz, 2017). For example, according to the results of one now-classic study, playing French (German) music in the wine aisle of a British supermarket dramatically increased the choice of French (German) wine (North et al., 1997, 1999). Along similar lines, other research has shown that consumers in a wine store spend more money and bought more expensive wines when classical music (vs. "Top 40" music) was played in the store (Areni & Kim, 1993).

Importantly, however, there is little research as far as documenting and understanding the role of background music on specifically healthy/indulgent food choices, as well as specific taste/flavour attributes, is concerned. With this question in mind, the current study investigated how multisensory atmospherics, especially background music, influences the consumer's preference for foods that vary in terms of their healthiness and taste/flavour.

Background music influences preference/choices for healthy and indulgent foods

The notions of healthy or indulgent (i.e., unhealthy) foods are undoubtedly contentious and multifaced constructs. Specific food categories have often been used for the classification (e.g., fruits, vegetables, milk, chicken etc. for 'healthy foods'; chips, fries, hot dogs, fried chicken etc. for 'indulgent foods'; see Biswas et al., 2019). Meanwhile, other research has used macronutrients (calorie and fat) to classify stimuli (i.e., lower calorie and fat for 'healthy foods'; higher calorie and fat for 'unhealthy foods'; see Peng-Li et al., 2021). Food category and macronutrient content are both associated with subjective evaluations of the healthfulness of foods (i.e., the perceived healthfulness of the foods; Bucher, Müller, & Siegrist, 2015). The perceived healthfulness of foods are positively associated with fruit/vegetable and fibre content, while being negatively assocaited with sugar and fat content, though there are no associations between some nutrients (e.g., saturated fat, protein) with the perceived healthfulness of foods (Bucher, Müller, & Siegrist, 2015). It also should be noted that cross-cultural differences in the associations with healthy foods have been reported (e.g., Banna et al., 2016; Peng-Li et al., 2021; Raghunathan, Naylor, & Hoyer, 2006; Werle, Trendel, & Ardito, 2013). For example, similarities and differences were recently observed in the interpretation of attributes of healthfulness across four countries (Peng-Li et al., 2021). 'Low sugar' and 'balanced in nutrition' were similarly perceived as healthy attributes across four countries, while the other attributes (e.g., 'low calorie', 'low sugar') were perceived differently. In Japan, where the present study was conducted, some food attributes (e.g., 'nutritionally balanced', 'fat', 'sugar', 'vitamin', and 'salt' content) were perceived as contributing to the (un)healthfulness of foods (Oshio et al., 2015). Taken together, therefore 'healthy foods' are perceived as subjectively healthy and contain balanced nutrition, a low-calorie count, and low sugar/fat, and vice versa for 'indulgent foods', though there are cultural differences.

Previously, a number of researchers have examined the influences of background music on consumers' preferences/choices for healthy and indulgent foods (Biswas et al., 2019; Fiegel et al., 2019, 2014; Huang & Labroo, 2020; Peng-Li et al., 2021). Several studies have investigated how basic auditory parameters (e.g., pitch, tempo, and volume) influence preferences/choices for healthy and indulgent foods (Biswas et al., 2019; Fiegel et al., 2019; Huang & Labroo, 2020; see also Knoferle et al., 2012). A separate line of ecologically valid empirical research has investigated the effects of music tempo on customer behaviours (e.g., time spent in a restaurant; see Knoeferle, Paus, & Vossen, 2017; Milliman, 1986). Other studies, meanwhile, have also investigated the effects of complex auditory parameters preferences/choices for healthy and indulgent foods (Fiegel et al., 2019, 2014; Peng-Li et al., 2021). 'Complex' can be defined operationally here as having multiple elements or attributes (Spence, 2020c). Complex auditory parameters include, say, music genres that differ in multiple elements or attributes (e.g., lower-pitched, guitar timbre, louder volume for rock/metal). Yet inconsistent results have been reported so far in terms of how background music influences preferences/choices specifically for healthy and indulgent foods.

Previous research on background music and healthy foods

Some studies have reported mixed findings in terms of how background music influences people's preferences/choices for healthy foods (Biswas et al., 2019; Fiegel et al., 2019, 2014; Huang & Labroo, 2020; Peng-Li et al., 2021). One line of research relying on basic auditory parameters has shown that lower (vs. higher) volume of music (Biswas et al., 2019) and higher (vs. lower) pitched music (Huang & Labroo, 2020) leads to increased healthy foods choices. However, the other study neither observed effects of volume (higher vs. lower), nor pitch (higher vs. lower), on the overall liking of healthy ingredients (bell peppers) (Fiegel et al., 2019).

Inconsistent findings have been reported in research on complex music parameters. For instance, Peng-Li and colleagues investigated how complex auditory parameters influence healthy food choices (Peng-Li et al., 2021). They composed a 'healthy soundtrack' and an 'unhealthy soundtrack' based on a matching task in which participants had to match auditory parameters (e.g., pitch, tempo, music genre) with the concepts of healthy and unhealthy eating. In their main study, the participants chose one of four food items while listening to the healthy (composition of auditory parameters related to healthy foods include a jazz piece, high-pitched piano, slow tempo) or unhealthy (composition of auditory parameters related to unhealthy foods, such as a guitar melody, lower-pitched, distorted piece) soundtrack. The results demonstrated that listening to the 'healthy soundtrack' increased the choice of healthy (vs. unhealthy) food items when compared to listening to the 'unhealthy soundtrack'. In contrast, the other study failed to reveal any significant differences in healthy food preferences as a function of music genre (classic, jazz, hip-hop, and rock; Fiegel et al., 2014).

Previous research on background music and indulgent food choice

Thus far, the evidence has not been conclusive in terms of how background music influences preferences/choices for indulgent (or unhealthy) foods. Two studies relying on basic auditory parameters have revealed that lower (vs. higher) volume increased preferences and choice for indulgent foods (Biswas et al., 2019; Fiegel et al., 2019). Fiegel and colleagues investigated the effects of pitch, tempo, and volume on unhealthy foods. Volume, but not pitch and tempo, were found to influence preferences for indulgent foods such that lower (vs. higher) volume increased the overall liking of milk chocolate (Fiegel et al., 2019). Similarly, Biswas and colleagues have demonstrated that higher (vs. lower) volume music resulted in participants choosing indulgent food options (Biswas et al., 2019).

In terms of complex music parameters, somewhat complicated findings have been reported. For instance, Fiegel and colleagues examined how music genres affect preferences for indulgent foods (Fiegel et al., 2014). The results demonstrated that Jazz (vs. Hip-hop, Rock) increased preferences for indulgent food (milk chocolate). Pin-Li and colleagues investigated whether 'healthy soundtrack (composed of Jazz piece with a piano instrument etc.)' and 'unhealthy soundtracks (composed of dissonant guitar melody with brass chord progression etc.)' would influence the choice of healthy versus unhealthy foods. The 'unhealthy' soundtrack did not increase the choice of indulgent foods compared with the 'healthy' soundtrack, while the 'healthy' (vs. 'unhealthy') soundtrack tended to increase the indulgent food choice.

Outstanding challenges

First, we investigate how crossmodal atmospherics, incorporating background music and taste/flavour, influence preferences for healthy and indulgent foods. Although previous research has already investigated the role of background music on healthy and indulgent (or unhealthy) foods (Biswas et al., 2019; Fiegel et al., 2014; Huang & Labroo, 2020; Peng-Li et al., 2021), these studies did not consider the role of taste/flavour of the food (i.e., sweet, savoury). Recently, it has been shown that the influences of auditory stimuli on people's food preferences were dependent on the taste/flavour of foods concerned (Motoki, Park, Pathak, & Spence, 2021). Specifically, higher-pitched sounds (vs. lower-pitched sounds) increased people's preferences for healthy (but not unhealthy) savoury foods. In contrast, higher-pitched sounds (vs. lower-pitched sounds) increased preferences for both healthy and unhealthy sweet foods. For this reason, the results of previous research (Biswas et al., 2019; Huang & Labroo, 2020; Fiegel et al., 2014; Peng-Li et al., 2021) might be somewhat inconsistent and the previous findings seem not to generalize across both savoury and sweet foods.

Second, we tested for the possible mechanisms associated with the effect of music on people's food preferences. In particular, we evaluate how the emotions that are evoked by (or associated with) music explain the influence of music genres on preferences for healthy and indulgent foods. It has been suggested that the effects of background music on people's preferences are often mediated by emotions (e.g., Reinoso-Carvalho et al., 2020; Spence, 2020a; Spence et al., 2014, 2019). Specifically, the mediating role of emotions is more likely to be involved in the case of complex (i.e., highly emotionally-valenced music genres; Spence, 2020a). However, previous research did not test for the mediating role of emotions on music genres on preferences for healthy and indulgent foods (Fiegel et al., 2014; Peng-Li et al., 2021). It has been suggested that music genres (Brown, 2012), healthy/indulgent foods (Peng-Li et al., 2021), and taste/flavour (sweet/savoury) are respectively associated with specific feelings (e.g., arousing, relaxing). Jazz and Classical are often rated as more pleasant and calming than Rock/Metal and Hip-hop (Brown, 2012; Fiegel et al., 2014; Rentfrow & Gosling, 2003). Healthy and unhealthy are matched with relaxing and arousing feelings, respectively (Peng-Li et al., 2021). Sweet taste/flavour seems to be more pleasant and calming than savoury taste/flavours (e.g., saltiness; Liang et al., 2021; Motoki & Velasco, 2021). Given these findings, it might be reasonable to expect that music genres would evoke distinct emotions, which, in turn, lead to affecting preferences for healthy/indulgent and sweet/savoury foods.

The present research

The present study aimed to investigate how music genres influence people's preferences for healthy and indulgent foods varying in their taste/flavour. Across two experiments (including one pre-registered replication), the participants were asked to answer how much they would like to eat each type of food (healthy savoury, indulgent savoury, healthy sweet, indulgent sweet) while listening to one of the naturalistic real-world (i.e., ecologically-valid) soundtracks (Jazz, Classical, Rock/Metal, Hip-hop). We also tested for whether emotions mediated the relations between soundtracks and food preferences.

Method

Design and participants

A 4 music genres (Jazz, Classical, Rock/Metal, Hip-hop) × 2 food types (healthy, indulgent) × 2 taste/flavours (savoury, sweet) experimental design, with music genres as a between-participants factor and food type and taste/flavour as within-participants factors, was conducted. The main dependent variable was food preferences (i.e., intention to eat).

In Experiment 1, a total of 397 Japanese participants (250 males, 139 females, 8 'prefer not to say', mean age of 43.26 years, *SD* = 10.01) took part in the online survey in exchange for 100 JPY as compensation. In Experiment 2 (a pre-registered replication of Experiment 1), the data from a total of 400 Japanese participants were collected. The data of one participant was missing due to the incompleteness of their responses. The final data in Experiment 2 incorporated 399 respondents (175 males, 219 females, and five 'prefer not to say', mean age of 39.62 years, *SD* = 9.57). The number of participants recruited was calculated using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). Given the difficulty of sample size calculations for complex experimental designs (see Lakens, 2020), we focused mainly on our post-hoc analyses. That is, interactions of four music genres and two food types for each level of taste/flavour.

A priori power analyses indicated that the number of required participants in each experiment was sufficient to detect a small to medium effect size (f = 0.15) with 95% power at an alpha level of .05. Participants were recruited on Lancers (https://www.lancers.jp/) in Experiment 1 and Crowdworks (https://crowdworks.jp) for Experiment 2. In both experiments, participants completed the survey on Qualtrics (https://www.qualtrics.com/jp/). Experiment 2 was pre-registered at AsPredicted (#66258). The studies were approved by the ethics committee of Miyagi University, Japan (No. 707. 2019-10-30), and was conducted in accordance with the Declaration of Helsinki.

Stimuli

Jazz, Classical, Hip-hop and Rock/Metal were used as music genres. This selection was based on previous research on music genre and food preferences (Fiegel et al., 2014). Fiegel and colleagues used Jazz, Classical, Hip-hop and Rock for music genres, and we generally follow this selection. We used Rock/Metal rather than Rock to make clear distinction between Rock/Metal and the other genres. Here, it should be noted that rock is a broad genre of music (e.g., alternative, punk, hard rock), and metal is a sub-genre of rock music (Phillips & Cogan, 2009). To represent the heavier end of rock music, we merged the broad (rock) and specific (metal) genre into the term of rock/metal. To increase the generalizability of soundtracks, we selected five soundtrack stimuli for each of four genres (Jazz, Classical, Rock/Metal, and Hip-hop). The soundtracks were selected on the basis of discussion between two of the authors (K.M. and N.T.) to match each soundtrack with each of the music genres with the assistance of the classification of music genres in Apple music (see Kantono et al., 2016, for a similar approach). Almost all the participants recognized the music genre as intended (see Results section for details). The list of soundtracks is shown in Table 1. The participants were randomly assigned to, and listened to, each of 20 soundtracks.

Sixteen food names were used, incorporating four food products selected to represent healthy savoury (soy hamburger, vegetable sandwich, vegetable chips, seafood pasta), indulgent savoury (beef-burger, beef sandwich, potato chips, meat pasta), healthy sweet (yogurt, low-fat milk, soymilk latte, soy serial bar), and indulgent sweet foods (pudding, chocolate milk, strawberry milk latte, chocolate bar).

A separate test was conducted to confirm whether our selection of food stimuli was rated as intended (see Appendix A, for details). The results of the pre-test (n = 40) showed that: (1) healthy foods (healthy sweet, healthy savoury) were perceived as healthier, lower in calories, and lower in fat content than indulgent foods (indulgent sweet, indulgent savoury), (2) sweet foods (healthy sweet, indulgent sweet) were rated as sweeter than savoury foods (healthy savoury, indulgent savoury), (3) savoury foods (healthy savoury, indulgent savoury) were rated as more savoury than sweet foods (healthy sweet, indulgent sweet), (4) indulgent foods (indulgent sweet, indulgent savoury) were related as more hedonic (more expected pleasure/exciting) than healthy foods (healthy sweet, healthy savoury). Taken together, therefore, the results of the pre-test generally support the selection of food stimuli. The basic statistics are reported in Table 1. It should be noted that the subjective ratings of the perceived healthfulness and nutrition are strongly associated with the objective nutrition (see Bucher et al., 2015; Motoki, Saito, Suzuki, & Sugiura, 2021). For our main study, the mean ratings of four food items were calculated within each food and taste/flavour type (i.e., healthy savoury foods, indulgent savoury foods, healthy sweet foods, indulgent sweet foods).

Table 1. Basic statistics of rating of each food category in the pre-test.

	Healthfulness	Calorie	Fat	Savoury	Sweet	Pleasure	Excitement
Healthy	4.89	4.17	3.74	4.72	3.23	3.96	4.05
savoury	(0.90)	(0.86)	(0.80)	(0.91)	(0.87)	(0.93)	(1.00)

Indulgent	2.78	6.13	5.78	5.83	3.27	5.56	5.38
savoury	(0.90)	(0.57)	(0.94)	(0.86)	(1.05)	(1.04)	(0.98)
Healthy	5.39	3.30	3.22	2.72	4.18	3.05	2.88
sweet	(0.69)	(0.77)	(0.88)	(0.91)	(0.96)	(0.71)	(0.84)
Indulgent	2.64	5.79	5.26	2.96	6.68	5.13	4.91
sweet	(0.86)	(0.75)	(1.28)	(1.39)	(0.47)	(1.08)	(0.89)

Note: Each cell represents mean and standard deviation. The ratings were made by 7-point Likert scale (1: not at all, 7: very much). The number of participants was 40.

Procedure

First, participants started with the sound check and responded to what sounds they heard. If their answer was correct, they moved to the main study. In the main study, the participants were instructed to play a soundtrack (one of 20 soundtracks assigned) and indicate their intention to eat each one of the 16 foods described by name (see Table 2). The ratings were made on a 7-point Likert scale anchored with 1: not at all and 7: very much. The order of 16 food names was randomized within participants. Each soundtrack lasted 30 seconds, and participants were allowed to repeatedly listen to this if they wanted to do so. Then, participants rated their valence (a 7-point scale for 1: very negative 7: very positive) and arousal (a 7-point scale for 1: very calming 7: very arousing) while listening to the soundtrack. The order of emotion ratings (valence, arousal) was randomized within participants. Finally, participants indicated which music genres they listened to from “Jazz”, “Classic”, “Rock/Metal”, “Hip-hop”, thus emphasizing the genre as the relevant dimension. They also indicated whether they understood the meaning of the lyrics of the soundtrack that they listened to by responding “Yes” or “No”. In Experiment 2, the participants rated the degree of familiarity of the soundtrack they listened to (from 1: not at all to 7: very much).

Table 2. Soundtracks used in the current experiments.

Music genres	Artists / Titles	Time	URL
Jazz 1	Art Blakey and the Jazz Messengers / Moanin'	0:00～0:30	https://youtu.be/Cv9NSR-2DwM

Jazz 2	Dave Brubeck / Take five	4:29～4:59	https://youtu.be/vmDDOFXSgAs
Jazz 3	Miles Davis / Walkin'	0:00～0:30	https://youtu.be/WMW3RloxEyA
Jazz 4	John Coltrane / Blue Train	0:00～0:30	https://youtu.be/HT_Zs5FKDZE
Jazz 5	Glen Gray / Moonlight serenade	0:00～0:30	https://youtu.be/9R3S-iPP0DA
Classical 1	E. Elgar / Salut d'amour Op.12	6:26～6:56	https://youtu.be/L9yiU-M1N4Q
Classical 2	Chopin / Nocturne No.2 Op.9-2	17:37～ 18:07	https://youtu.be/L9yiU-M1N1Q
Classical 3	J.S. Bach / Air on the G string	0:05～0:35	https://youtu.be/thQWqRDZj7E
Classical 4	J.S. Bach / Jesu, joy of man's desiring	2:52～3:22	https://youtu.be/OjC9UuA45y0
Classical 5	F. Liszt / Liebestraume - 3 notturnos No.3 As-Dur S.541/3	0:20～0:50	https://youtu.be/460vRlaonic
Hip-hop 1	2pac feat Dr. Dre / California love	0:46～1:16	https://youtu.be/5wBTdfAkqGU
Hip-hop 2	Kendrick Lamar / Humble	2:30～3:00	https://youtu.be/tvTRZJ-4EyI
Hip-hop 3	Cardi B, Bad Bunny & J Balvin / I like It	3:43～4:13	https://youtu.be/xTlNMmZKwpA
Hip-hop 4	Macklemore & Ryan Lewis / Thrift shop (feat. Wanz)	1:41～2:11	https://youtu.be/QK8mJJJvaes

Hip-hop 5	DJ Khaled / Top off (feat. Jay Z, Future, Beyoncé)	0:28～0:58	https://youtu.be/OHap45tpS38
Rock/Metal 1	Iron Maiden / The trooper	0:00～0:30	https://youtu.be/X4bgXH3sJ2Q
Rock/Metal 2	Metallica / Master of puppets	0:06～0:36	https://youtu.be/u6LahTuw02c
Rock/Metal 3	Slayer / Angel of death	0:15～0:45	https://youtu.be/TnRZhLRv6eM
Rock/Metal 4	Slipknot / Psychosocial	0:18～0:48	https://youtu.be/5abamRO41fE
Rock/Metal 5	Judas Priest / Painkiller	4:20～4:50	https://youtu.be/nM__lPTWThU

Statistical analyses

An analysis of variance (ANOVA) was conducted to assess the effects of four music genres (Jazz, Classical, Rock/Metal, Hip-hop), two food types (healthy, indulgent), and two taste/flavours (savoury, sweet) on our participants' food preferences. The mixed experimental design included music genre as a between-factor and taste/flavour and food type as within-factors. When a significant interaction term was observed, a post-hoc analysis was conducted to understand the interaction in more detail. The post-hoc analysis was conducted using Shaffer's modified sequentially rejective Bonferroni procedure (Shaffer, 1986). All statistical analyses were conducted using R software (R core Team, 2017). ANOVAs and subsequent multiple tests were conducted using anovakun, a package of R software (Iseki, 2013).

To determine whether emotions (valence and arousal) mediated the relations between music genres and food preferences, we conducted parallel mediation analysis using the PROCESS macro for SPSS with 5000 bootstrap samples. In this analysis, the music genres were entered as the independent variable (X), each of food preferences (e.g., healthy savoury, indulgent sweet) as the outcome variable (Y), both valence and arousal as the mediator variables (M). The indirect effects were estimated using unstandardized regression coefficients. If the 95% bias-corrected confidence intervals did not include zero, they were regarded as significant.

Results

Music genre recognition

Almost all the participants correctly discriminated the genre of the music as intended. Most of the participants allocated into the Jazz music condition answered that they were listening to Jazz (Experiment 1: 95.00%, Experiment 2: 93.14%). Almost all the participants allocated to the Classical music condition responded that they were listening to Classical (Experiment 1: 97.98%, Experiment 2: 97.96%). Nearly all the participants in the Hip-hop music condition responded that they listened to Hip-hop (Experiment 1: 95.88%, Experiment 2: 91.92%). Most of the participants allocated to Rock/Metal music condition answered that they were listening to Rock/Metal (Experiment 1: 98.02%, Experiment 2: 94.00%). Additionally, the majority of the participants (Experiment 1: 96.73%, Experiment 2: 97.25%) indicated that they were unable to understand the meaning of the lyrics, in those songs that included lyrics. These results confirm that our selection of music is associated with music category label, and the effects of lyrics are eliminated.

Food preferences

The results of the ANOVA revealed significant main effects of music genre, food type, and taste/flavour. Notably, a three-way interaction between music genre, food type, and taste/flavour was observed. By splitting the data into savoury and sweet foods, the interaction between music genres and food types was explored. Basic statistics and the statistical summaries of the results are shown in Tables 3 and 4. A graphical illustration is provided in Figure 1. Basic statistics for each soundtrack are shown in Appendix Table B.

Table 3. Descriptive statistics: Effects of music genres, taste/flavour, and food types on food preference

	Experiment 1	Experiment 2 (pre-registered replication)

Foods	Music genre	Mean	SD	Mean	SD
Healthy savoury	Jazz	3.97	0.98	3.96	1.09
	Classic	4.03	1.05	4.05	1.19
	Hip-hop	3.55	1.17	3.80	1.06
	Rock/Metal	3.14	1.26	3.33	1.25
Indulgent savoury	Jazz	4.56	1.06	4.35	1.06
	Classic	3.92	1.22	3.88	1.33
	Hip-hop	4.64	1.37	4.95	1.13
	Rock/Metal	4.43	1.48	4.48	1.41
Healthy sweet	Jazz	3.13	1.07	3.17	1.10
	Classic	3.79	1.20	3.69	1.11
	Hip-hop	2.92	1.20	3.06	1.12
	Rock/Metal	2.44	1.16	2.66	1.18
Indulgent sweet	Jazz	3.72	1.18	3.75	1.23
	Classic	4.19	1.16	4.11	1.26
	Hip-hop	3.46	1.24	3.62	1.20
	Rock/Metal	2.96	1.45	3.21	1.39
Valence	Jazz	4.93	0.99	4.94	0.99
	Classic	4.91	0.94	5.06	1.00
	Hip-hop	4.32	1.24	4.76	1.36
	Rock/Metal	4.05	1.47	4.43	1.29
Arousal	Jazz	3.28	1.40	3.14	1.39
	Classic	2.31	1.20	2.18	1.21
	Hip-hop	4.31	1.37	4.45	1.57
	Rock/Metal	4.74	1.47	5.00	1.24

Table 4. Statistical summaries of the results of ANOVAs.

	Experiment 1	**Experiment 2 (Pre-registered replication)**
4 music genres × 2 food types × 2 taste/flavour		

Music genre	$F_{3, 393} = 11.411$, $p < .001$, $\eta_p^2 = 0.080$	$F_{3, 395} = 5.701$, $p < .001$, $\eta_p^2 = 0.042$
Food type	$F_{1, 393} = 217.686$, $p < .001$, $\eta_p^2 = 0.357$	$F_{1, 395} = 199.360$, $p < .001$, $\eta_p^2 = 0.335$
Taste/flavour	$F_{1, 393} = 158.950$, $p < .001$, $\eta_p^2 = 0.288$	$F_{1, 395} = 196.849$, $p < .001$, $\eta_p^2 = 0.333$
The two-way interaction	$F_{3, 393} = 21.698$, $p < .001$, $\eta_p^2 = 0.142$	$F_{3, 395} = 21.008$, $p < .001$, $\eta_p^2 = 0.138$
Savoury foods: 4 music genres × 2 food types		
Music genre	$F_{3, 393} = 3.691$, $p = .012$, $\eta_p^2 = 0.027$	$F_{3, 395} = 4.024$, $p = .008$, $\eta_p^2 = 0.030$
Food type	$F_{1, 393} = 136.316$, $p < .001$, $\eta_p^2 = 0.258$	$F_{1, 395} = 119.727$, $p < .001$, $\eta_p^2 = 0.233$
The interaction	$F_{3, 393} = 26.134$, $p < .001$, $\eta_p^2 = 0.166$	$F_{3, 395} = 30.734$, $p < .001$, $\eta_p^2 = 0.189$
Sweet foods: 4 music genres × 2 food types		
Music genre	$F_{3, 393} = 24.312$, $p < .001$, $\eta_p^2 = 0.157$	$F_{3, 395} = 12.8345$, $p < .001$, $\eta_p^2 = 0.089$
Food type	$F_{1, 393} = 89.947$, $p < .001$, $\eta_p^2 = 0.186$	$F_{1, 395} = 128.441$, $p < .001$, $\eta_p^2 = 0.245$
The interaction	$F_{3, 393} = 0.523$, $p = 0.667$, $\eta_p^2 = 0.004$	$F_{3, 395} = 0.591$, $p = .622$, $\eta_p^2 = 0.005$

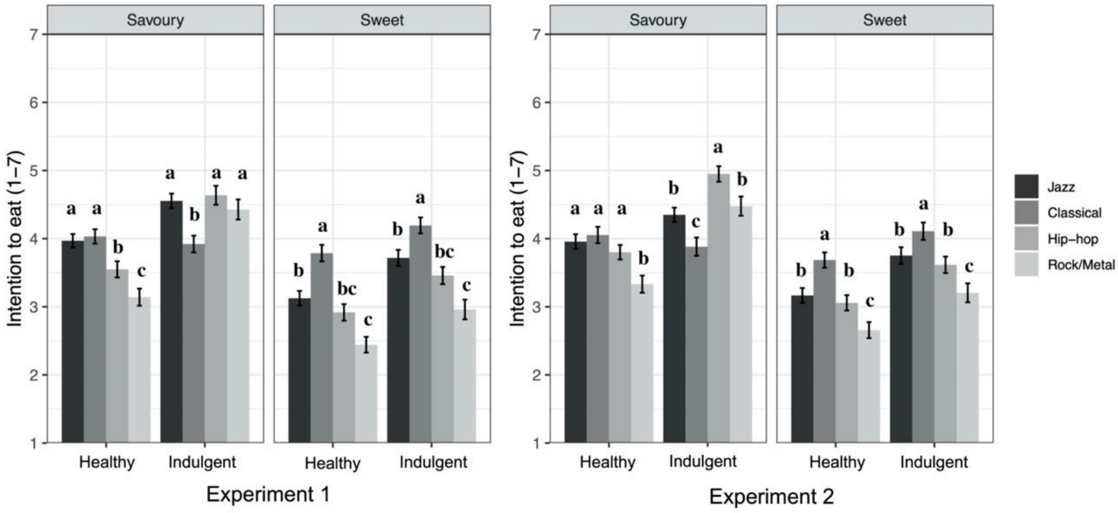

Figure 1. Effect of music genres, food types, and taste/flavour on the intention to eat. Ratings of on a 1-7 Likert visual scale (‘not at all’ to ‘very much’). Error bar represents standard error. Different letters (e.g., a/b, b/c) indicate statistically significant differences among situations within each food type (adj. $p < .05$ using Shaffer's modified sequentially rejective Bonferroni procedure; Shaffer, 1986). Experiment 1 (Jazz: n = 100, Classical: n = 99, Hip-hop: n = 97, Rock/Metal: n = 101). Experiment 2 (Jazz: n = 102, Classical: n = 98, Hip-hop: n = 99, Rock/Metal: n = 100).

For savoury foods, the interaction between music genre and food type was observed. Intriguingly, listening to Jazz and Classical music increased people’s preferences for healthy savoury foods as compared with Rock/Metal and Hip-hop. Listening to Hip-hop music also increased preferences for healthy savoury foods compared with listening to Rock/Metal. No significant differences were found in terms of people’s preferences for healthy savoury food when listening to either Jazz or Classical music. Additionally, listening to Rock/Metal, Hip-hop, and Jazz music increased people’s preferences for indulgent savoury foods as compared with Classical music. No significant differences were found in preferences for indulgent savoury food as a function of listening to Jazz, Rock/Metal, or Hip-hop music.

For sweet foods, there was a main effect of the music genre, while no interaction between sounds and food types was observed. The main effect of music genre revealed that listening to Classical music increased people’s preferences for sweet foods as compared with the other music genres. Jazz and Hip-hop also increased preferences for sweet foods compared with Rock/Metal. No significant differences were found in people’s preferences for sweet food between Jazz and Hip-hop music. Statistical summaries of pairwise comparisons are shown in Table 5.

Table 5. Statistical summaries of pairwise comparisons. Influence of music genres, food types, and taste/flavour on food preferences.

Experiment 1				**Experiment 2 (Pre-registered replication)**			
Healthy savoury				*Healthy savoury*			
Pair	Diff	t-value	adj. p	Pair	Diff	t-value	adj. p
Classical > Rock/Metal	0.892	5.626	<.001	**Classical > Rock/Metal**	0.721	4.402	<.001
Jazz > Rock/Metal	0.829	5.243	<.001	**Jazz > Rock/Metal**	0.623	3.844	<.001
Classical > Hip-hop	0.484	3.022	.008	**Hip-hop > Rock/Metal**	0.468	2.864	.013
Jazz > Hip-hop	0.421	2.636	.026	Classical = Hip-hop	0.253	1.541	.372
Hip-hop > Rock/Metal	0.408	2.560	.026	Jazz = Hip-hop	0.155	0.956	.680
Jazz = Classical	-0.063	0.395	.693	Jazz = Classical	-0.098	0.599	.680
Indulgent savoury				*Indulgent savoury*			
Pair	Diff	t-value	adj. p	Pair	Diff	t-value	adj. p
Hip-hop > Classical	0.715	3.866	.001	**Hip-hop > Classical**	1.067	6.048	<.001
Jazz > Classical	0.633	3.451	.002	**Hip-hop > Jazz**	0.599	3.430	.002
Rock/Metal > Classical	0.507	2.767	.018	**Rock/Metal > Classical**	0.595	3.381	.002

Hip-hop = Rock/Metal	0.208	1.133	.774	**Hip-hop > Rock/Metal**	0.472	2.689	.022
Jazz = Rock/Metal	0.127	0.694	.976	**Jazz > Classical**	0.468	2.672	.022
Jazz = Hip-hop	-0.082	0.442	.976	Jazz = Rock/Metal	-0.127	0.729	.466
Sweet				*Sweet*			
Pair	Diff	t-value	adj.p	Pair	Diff	t-value	adj.p
Classical > Rock/Metal	1.289	8.401	<.001	**Classical > Rock/Metal**	0.967	6.155	<.001
Classical > Hip-hop	0.803	5.179	<.001	**Classical > Hip-hop**	0.561	3.562	.001
Jazz > Rock/Metal	0.720	4.700	<.001	**Jazz > Rock/Metal**	0.528	3.397	.002
Classical > Jazz	0.570	3.704	.001	**Classical > Jazz**	0.438	2.805	.016
Hip-hop > Rock/Metal	0.486	3.153	.004	**Hip-hop > Rock/Metal**	0.406	2.591	.020
Jazz = Hip-hop	0.233	1.507	.133	Jazz = Hip-hop	0.122	0.785	.433

Note: Bold denotes significant difference (adj. $p < .05$ using Shaffer's modified sequentially rejective Bonferroni procedure; Shaffer, 1986).

Emotions and familiarity

The results of the ANOVA revealed significant main effects of the music genre (Experiment 1: $F_{(3, 393)} = 13.870$, $p < .001$, $\eta_p^2 = 0.096$; Experiment 2: $F_{(3, 395)} = 5.487$, $p = .001$, $\eta_p^2 = 0.040$). In particular, listening to Jazz and Classical music increased positivity as compared to listening to Rock/Metal and Hip-hop. No significant differences were found in valence between Jazz and Classical nor between Rock/Metal and Hip-hop. An additional ANOVA was conducted in order to assess the effect of musical genre (Jazz, Classical, Rock/Metal, or Hip-hop) on arousal. The ANOVA results revealed a significant main effect of the music genre (Experiment 1: $F_{(3, 393)} = 63.098$, $p < .001$, $\eta_p^2 = 0.325$; Experiment 2: $F_{(3, 395)} = 86.957$, $p < .001$, $\eta_p^2 = 0.398$). Classical music increased the feeling of calmness as compared with the other music genres. Jazz music increased feelings of calmness as compared with the Hip-hop and Rock/Metal. Hip-hop music increased feelings of calmness as compared with Rock/Metal. The results of pairwise comparisons are shown in the Appendix.

An ANOVA was conducted to assess the effects of music genres (Jazz, Classical, Rock/Metal, Hip-hop) on familiarity in Experiment 2. The results of ANOVA revealed significant main effects of music genre ($F_{(3, 395)} = 55.584$, $p < .001$, $\eta_p^2 = 0.297$). Classical music was rated as more familiar as compared to the other music genres (all adj. ps < .05). Jazz music was rated as more familiar than Hip-hop and Rock/Metal (all adj. ps < .05). No significant differences were found between Jazz and Classical, nor between Hip-hop and Rock/Metal. Given the differences in familiarity between the music genres, we additionally conducted an exploratory analysis of covariance (ANCOVA) to assess the effects of music genres (Jazz, Classical, Rock/Metal, Hip-hop), food types (healthy, indulgent), and taste/flavour (sweet, savoury) on food preference with familiarity as a covariate. The results of the details are shown in Appendix.

The mediating role of emotions on the relations between music genres and preferences for savoury foods

We tested whether three music genres (i.e., Jazz, Hip-hop, Rock/Metal) increased preferences for indulgent savoury foods as compared to the Classical music mediated by emotions (valence and arousal). The results revealed that both valence and arousal mediated the relationship between music genres and preferences for indulgent savoury foods (see Figure 2). That is, the three music genres (i.e., Jazz, Hip-hop, Rock/Metal) induced more arousing feelings, and higher levels of arousing feelings were associated with higher preferences for indulgent savoury foods. Oppositely, the three music genres (i.e., Jazz, Hip-hop, Rock/Metal) induced more negative feelings, and higher levels of negative feelings were associated with lower preferences for indulgent savoury foods.

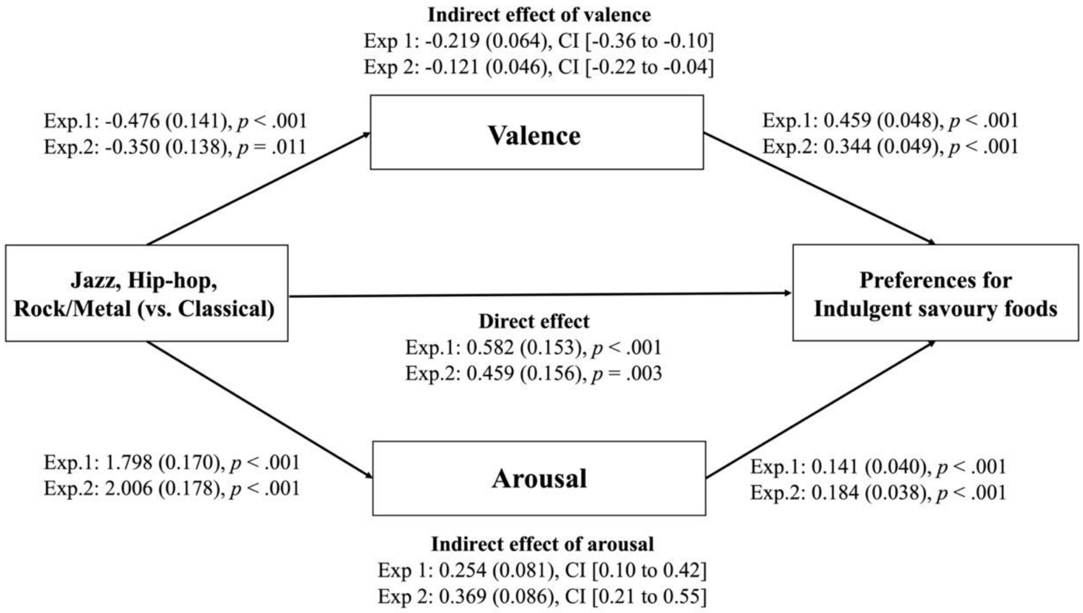

Figure 2. Arousal (and negative valence) mediated the relations between Jazz, Hip-hop, and Rock/Metal (vs. Classical) and preferences for indulgent savoury foods. Unstandardized coefficients are displayed. Standard errors are represented in parentheses.

We also tested for whether Jazz and Classical (vs. Hip-hop and Rock/Metal) increased our participants' preferences for healthy savoury foods through emotions. The results revealed that valence, but not arousal, mediated the relationship between music genre and preference for healthy savoury foods (see Figure 3). That is, Jazz and Classical (vs. Hip-hop and Rock/Metal) music induced more positive feelings, and higher levels of positive feelings were associated with higher preferences for healthy savoury foods.

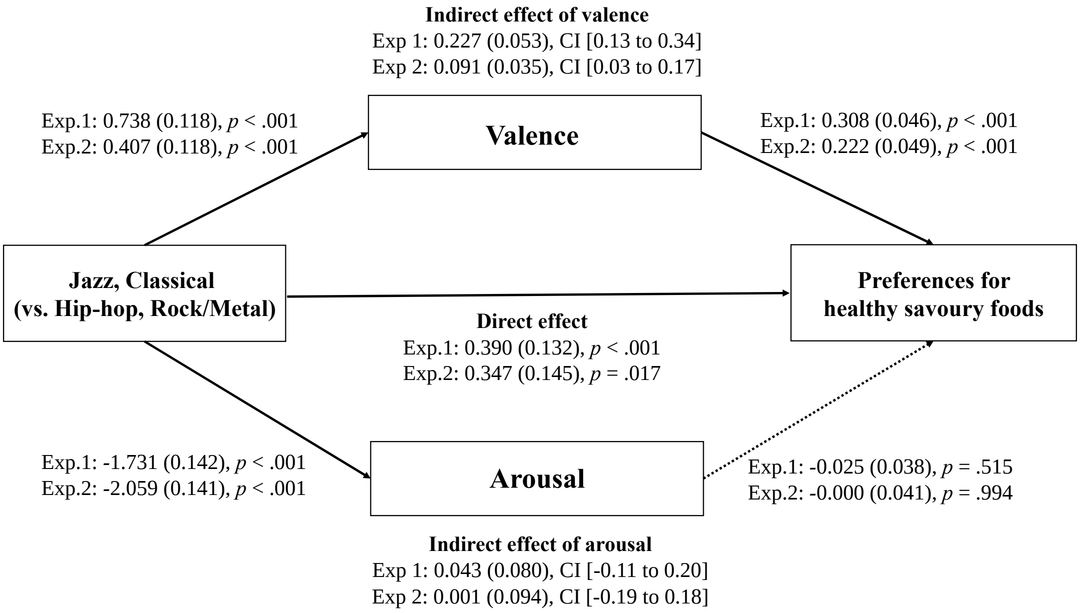

Figure 3. Positive valence mediated the relations between Jazz and Classical (vs. the other genres) and preferences for indulgent savoury foods. Unstandardized coefficients are displayed. Standard errors are represented in parentheses.

The mediating role of emotions on the relations between music genres and preferences for sweet foods

We examined whether Classical (vs. the other music genres) increased preferences for healthy and indulgent sweet foods through emotions. The results revealed that valence mediated the relationship between music genres and preferences for healthy and indulgent sweet foods (Figures 4 and 5). That is, Classical (vs. the other music genres) induced more positive feelings, and higher levels of positive feelings were associated with higher preferences for healthy and indulgent sweet foods. Only in Experiment 2 did arousal mediate the relationship between music genres and preferences for indulgent sweet foods. That is, Classical (vs. the other music genres) induced more calming feelings, and higher levels of calming feelings were associated with higher preferences for indulgent sweet foods.

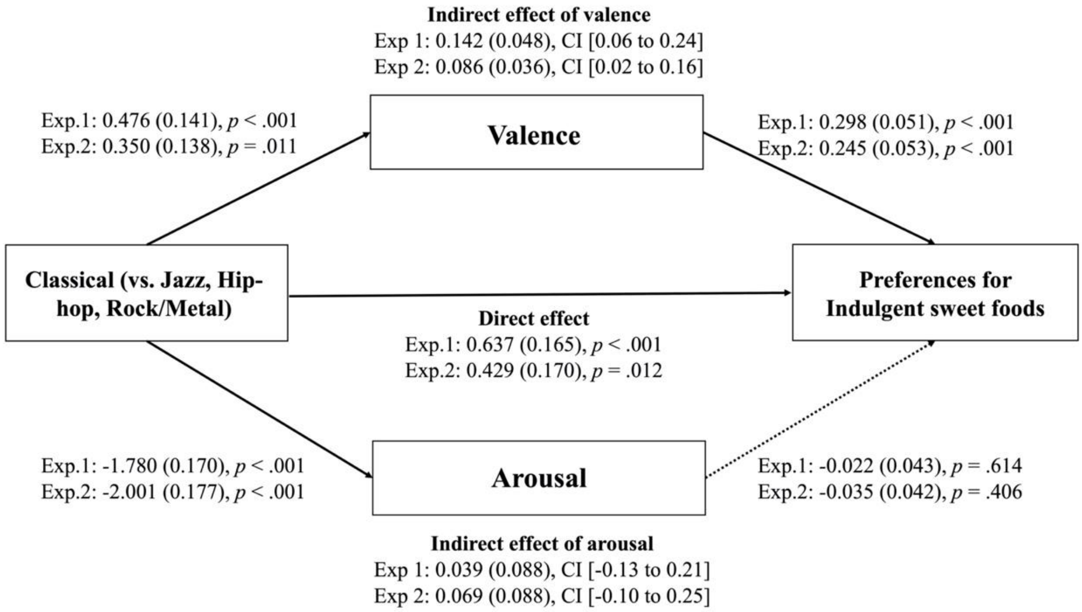

Figure 4. Positive valence mediated the relations between Classical (vs. the other genres) and preferences for indulgent savoury foods. Unstandardized coefficients Unstandardized coefficients are displayed. Standard errors are represented in parentheses.

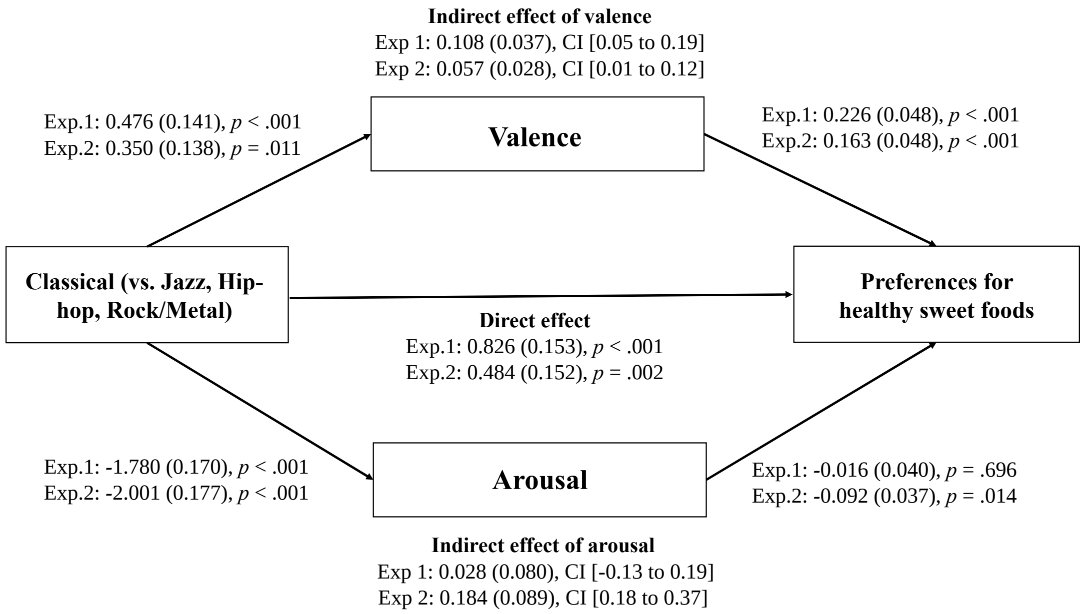

Figure 5. Positive valence mediated the relations between Classical (vs. the other genres) and preferences for healthy savoury foods. Unstandardized coefficients

Unstandardized coefficients are displayed. Standard errors are represented in parentheses.

General discussion

The current research investigated the interactive effect of background music and taste/flavour on preferences for healthy and indulgent foods. Previously, inconsistent findings have been reported in the literature in terms of how background music influences people's preferences for healthy and indulgent foods. By considering music genre (Jazz, Classical, Rock/Metal, Hip-hop), food type (healthy, indulgent), and taste/flavour (sweet, savoury) simultaneously, we are able to provide evidence that helps to disentangle the mixed results and first demonstrate the nuanced effects of music genres on preferences for healthy and indulgent foods. The results revealed that listening to jazz and classical music increased people's preferences for healthy savoury foods (e.g., a vegetable sandwich) as compared to listening to rock/metal and hip-hop. Listening to rock/metal, hip-hop, and jazz music increased our participants' preferences for indulgent savoury foods (e.g., beef sandwich) as compared to listening to classical music. Additionally, listening to classical music increased people's preference for both healthy (e.g., low-fat milk) and indulgent (e.g., milk chocolate) sweet foods as compared with the other music genres. Our results also revealed the mediating role of emotions on the relations between music genres and food preferences. Collectively, our findings suggest how background music influences food preferences, and provide practical implications to store managers in terms of what kind of music should be played.

Preferences for healthy foods influenced by background music

This study added new evidence to the question of how ambient music influences people's preferences for specific food types. Earlier research has reported that basic auditory parameters (e.g., volume, pitch; Biswas et al., 2019; Fiegel et al., 2019; Huang & Labroo, 2020) and complex auditory parameters (e.g., music genres) (Fiegel et al., 2014; Peng-Li et al., 2021) influence preferences for healthy and indulgent foods. However, the findings reported so far were inconsistent. Some studies have reported that lower (vs. higher) volume (Biswas et al., 2019) and higher (vs. lower) pitched music increased preferences for healthy foods (Huang & Labroo, 2020), while the other study did not find any effects of pitch and volume on people's preference for healthy food (Fiegel et al., 2019). Although 'healthy soundtrack (including jazz piece)' increased choice of healthy foods compared with its counterpart, the other research found that jazz (vs. hip-hop, rock) enhanced preferences for indulgent foods (Fiegel et al., 2014). By combining music genre, food type, and taste/flavour, our findings help to disentangle the mixed results that have been reported previously. Specifically, listening to classical music increased preferences for both healthy and indulgent sweet foods in comparison with the other music genres. In contrast, indulgent savoury foods were least preferred during listening to classical music (vs. the other genres). Moreover, listening to jazz and classical music (vs. rock/metal and hip-hop) increased people's preferences for healthy savoury foods.

Relation of our findings with previous research on sounds and food as well as crossmodal correspondences

Our findings appear consistent with previous research on the effects of (speech) sounds on healthy/indulgent food evaluations. In particular, Motoki and his colleagues have demonstrated that the sound frequency incorporated in fictitious brand names differently influences the perceived appropriateness of foods depending on the taste/flavour and the healthfulness (Motoki et al., 2021; also see Pathak, Calvert, & Motoki, 2020). Fictitious brand names including higher (vs. lower) frequency sounds are perceived as more appropriate for healthy and indulgent sweet foods as well as healthy savoury foods (but not indulgent savoury foods). Our findings are partly in line with the findings of Motoki et al. and demonstrate that listening to classical and jazz music increased preferences for healthy and indulgent sweet foods as well as healthy savoury foods (but not indulgent savoury foods) in comparison with rock/metal music. classical and jazz music might possibly consist of higher frequency of sounds especially in our stimuli compared with rock/metal music, though acoustic analyses are needed to verify our speculation (see Corrêa & Rodrigues, 2016). Together, our findings suggest that music genres and speech sounds might similarly influence food preferences.

Our findings also appear in line with the previous research on crossmodal correspondences. A growing body of research has demonstrated that auditory parameters are associated (or matched) with specific tastes (e.g., Knöferle & Spence, 2012; Motoki et al., 2020; Simner, Cuskley, & Kirby, 2010; Wang, Wang, & Spence, 2016). Specifically, auditory parameters likely linked with classical music (e.g., higher pitch, softer, slow tempo, consonant melody) are matched with sweetness (Knöferle & Spence, 2012; Mesz, Trevisan, & Sigman, 2011; Wang, Woods, & Spence, 2015). One study has even suggested that certain pieces of classical music (e.g., *Trois Gymnopédies, No.2 Lent et triste* by Erik Satie) are excellent examples of 'sweet music' (Kontukoski et al., 2015). Moreover, high-pitched voiceover advertisements increase the preference for sweet foods (Motoki, Saito, Nouchi, Kawashima, & Sugiura, 2019a). Although classical music is matched with the concept of healthy foods (Peng-Li et al., 2021), classical music is also associated with sweetness (Kontukoski et al., 2015). The association of classical music with sweetness might be more pronounced than that with healthy foods. Taken together, sweet-music correspondences might therefore be expected to override the healthy-music associations, and this might explain why listening to classical (vs. the other) music increased preferences for healthy as well as indulgent sweet foods.

Emotion mediates the relations between music genres and food preferences

Our findings demonstrated that music-evoked (or associated) emotions mediate the relationship between music genres and food preferences. It has been suggested that the effects of background music on people's preferences are mediated by emotions (e.g., Biswas et al., 2019; Fiegel et al., 2014; Spence, 2020a). Relevant to the present findings, Biswas and colleagues have suggested that lower (vs. higher) volume music induces feelings of calmness. Fiegel et al. (2014) have also reported that music-evoked positive valence leads to preferences for certain foods (milk chocolate and bell pepper). However, it is still unclear how music-evoked emotions influence different types of food preference. Our findings reveal that the effects of emotions on food preferences are dependent on food types (healhty, unhealhty) and taste/flavour (sweet, savoury). Specifically, music-evoked (or associated) positive valence appears to lead to a preference for sweet foods and healthy savoury foods. In contrast, the feeling of arousal induced by muic increased the preference for indulgent savoury foods (though see Ferber & Cabanac, 1987; Kupfermann, 1964, for the role of loudness on the liking for sweetness). Collectively, the present findings start to reveal the psychological underpinings of why specific music genres influece food preferences and lead to a better understading of the mediating role of music-evoled emotions on food preferences.

Practical implications

Our findings provide practical implications for food practitioners. Among retail atmospherics, music ambience is easily manipulated and controllable by restaurant and store managers alike. Moreover, it seems more straightforward that restaurant and store managers choose the background music relying on genres rather than basic auditory parameters (e.g., pitch, tempo). Restaurants and stores that mostly sell sweet foods (think ice-cream parlour) might want to choose Classical music (e.g., *Jesu, joy of man's desiring* by J.S. Bach). For restaurants and stores that mostly sell healthy savoury foods (e.g., vegetable sandwich), playing classical or jazz seems better than the other genres. It is also recommended that restaurants and stores that mostly sell indulgent savoury foods (e.g., beef sandwich) might want to play jazz, hip-hop, or rock/metal and avoid playing classical music. Additionally, in the festivals or events that specific music genres are played (e.g., rock festival, jazz festival, classical concert), event planners can design menu options accordingly. Furthermore, it seems possible that sounds in food advertisements can be well designed based on our findings.

Limitations and directions for future research

There are some limitations to our research. First, the present research did not consider the basic auditory parameters (e.g., volume, tempo, pitch), as this was not the primary aim of our study. It seems extremely difficult to disentangle basic auditory parameters from music genres. This is because each music genre consists of a composition of different multiple auditory parameters (e.g., higher volume, lower pitch, guitar sound, dissonant consonant for rock/metal). Nevertheless, further research should need which basic auditory parameters are important for our findings. Second, the selections of music genres might influence our findings. We selected four music genres that are similar to previous research (Fiegel et al., 2014). However, there are many other kinds of music genre than have been studied here (e.g., Blues, Folk, Country, Religious, Electronica; see Helwig & Palmer, 2018; Kantono et al., 2016; Levitan, Charney, Schloss, & Palmer, 2015). Some of ethnic music (e.g., French music, Japanese music) might nudge toward making healthy (or indulgent) food choices. Japanese country-of-origin is positively associated with perceived healthfulness of the food (Dobrenova, Grabner-Kräuter, & Terlutter, 2015). Listening to Japanese music might evoke healthy mindsets, and possibly lead to healthier food choices. Future research should therefore consider expanding our findings by using a more diverse range of musical genres.

Third, we did not investigate the effects of background music on actual sales. Further research should therefore investigate whether our findings can be generalized to real-world purchasing behaviours. Fourth, each of music genres might work as an ethnic priming and influence our findings. For example, in our selection, most of artists in jazz and hip-hop genres are North Americans and most of artists in classical are (Western) European. The links between music genres and ethnicity might prime concepts related to food categories and influence food preferences. Further study should use diverse soundtracks varying ethnicity and try to replicate our findings. Moreover, we did not consider the effects of sound symbolism and/or prosody. Although most of participants reported being unable to understand the lyrics, sound symbolism and/or prosody might nevertheless still be expected to influence food preferences. Additionally, we did not consider individual differences in music preferences. Those who prefer specific music genre (e.g., metal; see Swami et al., 2013) might differently evaluate foods from those who do not.

Another limitation is that we did not consider alternative mediators. Although we focus on the emotions as the mediator, it seems also possible that semantic meaning works as a mediator. People typically associate classical music with the concept of luxury (and possibly expensive prices) (e.g., Areni & Kim, 1993; North, Shilcock, & Hargreaves, 2003) and possibly quiet classical music with the concept of sereneness and sophistication (see Lammers, 2003; Wilson, 2003). Given that playing classical music makes people spend more and/or purchase more expensive products (Areni & Kim, 1993), and presumably healthy food tends to be more expensive than indulgent food (Haws, Reczek, & Sample, 2017), the explanation for any effects of classical music might be based on the semantic concept of price. It might be also possible that statistical co-occurrence of music and foods might explain our findings (see Knöferle & Spence, 2012; Spence, 2011). It can be the case that certain types of music (e.g., Classical) tend statistically to co-occur with particular types of foods (e.g., sweet foods) in store environments. Further study should investigate alternative mechanisms of music genres on food preferences.

Conclusions

To the best of our knowledge, this is the first study to investigate the interactive effects of music genre, food type, and taste/flavour on food preferences. Our results help to disentangle the previous inconsistent findings while also providing evidence that background music shape preferences for foods dependent on the interactions of music genres, food types and taste/flavour, and provide practical implications for store managers and marketers to play the most appropriate music in stores.

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Appendix A. Pre-test for food stimuli.

We conducted a pre-test to confirm whether our food stimuli were rated as intended. Forty Japanese participants were recruited, as in the main studies (see the details of the Method section) (27 males, 13 females, mean age of 45.03 years, *SD* = 7.91). The data from all participants were analyzed. The participants had to respond to seven ratings (perceived healthfulness, expected calorie count, expected fat content, expected savoury taste/flavour, expected sweet taste/flavour, expected pleasure, expected excitement) for 16 food items. Expected pleasure and excitement were collected to measure hedonic feelings. The ratings were made by a 7-point Likert scale from 1: not at all to 7: very much. The questions include “Healthfulness: How healthy do you think the following foods are?”, “Calories: How many calories do you think the following foods contain?”, “Fat: How much fat do you think the following foods contain?”, “Savoury: How savoury do you think the following foods are?”, “Sweet: How sweet do you think the following foods are?”, “Pleasure: How much pleasure do you expect to feel on eating the following foods?”, “Excitement: How much excitement do you expect to feel on eating the following foods?”. The mean ratings of four food items were calculated within each food and taste/flavour type (i.e., healthy savoury foods, indulgent savoury foods, healthy sweet foods, and indulgent sweet foods). The order of the seven ratings and the 16 food names was randomized within participants. ANOVAs were conducted to assess the effects of food types (healthy, indulgent) and taste/flavour (sweet, savoury) on each of ratings. The results revealed that most of the ratings were as intended, though some interaction effects were also observed. The statistical summaries are shown in Appendix Table A.

Appendix Table A. Statistical summaries of the pre-test results of ANOVAs.

Dependent variable	Main effect		Post-hoc analyses	
Healthfulness	Taste/flavor	$F = 2.770$, $p = .104$, $\eta_p^2 = 0.066$	Indulgent savoury > Indulgent sweet	$F = 17.142$, $p < .001$, $\eta_p^2 = 0.305$
	Food types	$F = 299.138$, $p < .001$, $\eta_p^2 = 0.885$	Healthy savoury = Healthy sweet	$F = 1.058$, $p = .310$, $\eta_p^2 = 0.026$
	The interaction	$F = 21.717$, $p < .001$, $\eta_p^2 = 0.358$		
Calories	Taste/flavor	$F = 28.423$, $p < .001$, $\eta_p^2 = 0.422$	Indulgent savoury > Indulgent sweet	$F = 47.815$, $p < .001$, $\eta_p^2 = 0.5508$
	Food types	$F = 378.275$, $p < .001$, $\eta_p^2 = 0.907$	Healthy savoury > Healthy sweet	$F = 6.595$, $p = .014$, $\eta_p^2 = 0.145$
	The interaction	$F =18.917$, $p < .001$, $\eta_p^2 = 0.327$		
Fat	Taste/flavor	$F = 11.255$, $p = .002$, $\eta_p^2 = 0.224$	Indulgent savoury > Indulgent sweet	$F = 11.255$, $p = .002$, $\eta_p^2 = 0.224$
	Food types	$F = 200.773$, $p < .001$, $\eta_p^2 = 0.837$	Healthy savoury > Healthy sweet	$F = 200.773$, $p < .001$, $\eta_p^2 = 0.837$
	The interaction	$F = 0.004$, $p = .949$, $\eta_p^2 = 0.000$		
Savoury	Taste/flavor	$F = 181.273$, $p < .001$, $\eta_p^2 = 0.823$	Indulgent savoury > Healthy savoury	$F = 76.865$, $p < .001$, $\eta_p^2 = 0.663$

	Food types	$F = 30.091$, $p < .001$, $\eta_p^2 = 0.436$	Indulgent sweet = Healthy sweet	$F = 1.650$, $p = .207$, $\eta_p^2 = 0.041$
	The interaction	$F = 17.508$, $p < .001$, $\eta_p^2 = 0.310$		
Sweet	Taste/flavor	$F = 158.374$, $p < .001$, $\eta_p^2 = 0.802$	Indulgent savoury = Healthy savoury	$F = 0.141$, $p = .709$, $\eta_p^2 = 0.004$
	Food types	$F = 132.191$, $p < .001$, $\eta_p^2 = 0.772$	Indulgent sweet > Healthy sweet	$F = 228.070$, $p < .001$, $\eta_p^2 = 0.854$
	The interaction	$F = 183.247$, $p < .001$, $\eta_p^2 = 0.825$		
Pleasure	Taste/flavor	$F = 39.778$, $p < .001$, $\eta_p^2 = 0.505$	Indulgent savoury > Indulgent sweet	$F = 50.068$, $p < .001$, $\eta_p^2 = 0.562$
	Food types	$F = 90.755$, $p < .001$, $\eta_p^2 = 0.699$	Healthy savoury = Healthy sweet	$F = 9.881$, $p = .003$, $\eta_p^2 = 0.202$
	The interaction	$F = 8.616$, $p = .006$, $\eta_p^2 = 0.181$		
Excitement	Taste/flavor	$F = 54.135$, $p < .001$, $\eta_p^2 = 0.581$	Indulgent savoury > Indulgent sweet	$F = 89.647$, $p < .001$, $\eta_p^2 = 0.697$
	Food types	$F = 74.386$, $p < .001$, $\eta_p^2 = 0.656$	Healthy savoury = Healthy sweet	$F = 9.165$, $p = .004$, $\eta_p^2 = 0.190$
	The interaction	$F = 17.297$, $p < .001$, $\eta_p^2 = 0.307$		

Appendix Table B. Basic statistics for each soundtrack.

Music genres	Artists / Titles	Healthy savoury		Indulgent savoury		Healthy sweet		Indulgent sweet		Valence		Arousal	
		Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2	Exp. 1	Exp. 2
Jazz 1	Art Blakey and the Jazz Messengers / Moanin'	4.13	4.30	4.68	4.32	3.06	3.39	3.73	4.04	5.29	5.10	3.71	2.71
Jazz 2	Dave Brubeck / Take five	3.91	3.77	4.79	4.46	3.12	3.05	3.77	3.54	5.00	4.91	3.38	3.24
Jazz 3	Miles Davis / Walkin'	4.03	3.95	4.57	4.40	2.86	3.05	3.11	3.56	4.78	4.80	3.50	4.15
Jazz 4	John Coltrane / Blue train	4.08	3.80	4.63	4.53	3.31	2.99	3.95	3.71	4.71	4.85	3.14	3.10
Jazz 5	Glen Gray / Moonlight serenade	3.68	3.95	4.07	4.04	3.25	3.35	3.96	3.91	4.84	5.05	2.63	2.50
Classical 1	E. Elgar / Salut d'amour Op.12	4.06	3.71	3.94	3.92	4.01	3.30	4.10	3.96	4.80	5.26	2.45	2.00
Classical 2	Chopin / Nocturne No.2 Op.9-2	3.90	4.04	3.83	4.00	3.58	3.69	4.15	4.31	4.50	5.00	2.22	2.05
Classical 3	J.S. Bach / Air on the G string	4.14	4.26	4.10	3.77	3.88	3.79	4.24	4.21	4.85	5.05	2.10	2.52
Classical 4	J.S. Bach / Jesu, joy of man's desiring	4.18	4.36	4.08	4.01	3.89	4.00	4.43	4.12	5.00	5.37	2.80	2.21

Classical 5	F. Liszt / Liebestraume - 3 notturnos No.3 As-Dur S.541/3	3.88	3.88	3.67	3.71	3.57	3.65	4.06	3.92	5.33	4.63	2.00	2.11
Hip-hop 1	2pac feat Dr.Dre / California love	3.43	3.34	4.78	4.84	2.40	2.84	3.17	3.03	4.00	4.20	4.44	4.35
Hip-hop 2	Kendrick Lamar / Humble	3.68	4.02	4.98	5.12	3.26	3.35	3.91	4.10	4.70	5.24	4.45	4.52
Hip-hop 3	Cardi B, Bad Bunny & J Balvin / I like it	3.85	4.15	4.59	4.46	3.39	3.45	3.93	3.79	4.35	4.60	4.40	4.30
Hip-hop 4	Macklemore & Ryan Lewis / Thrift shop (feat. Wanz)	3.50	3.90	4.79	5.29	2.73	2.84	3.45	3.49	4.50	4.40	4.35	4.45
Hip-hop 5	DJ Khaled / Top off (feat. Jay Z, Future, Beyoncé)	3.26	3.56	4.04	5.04	2.75	2.78	2.78	3.67	4.00	5.39	3.90	4.67
Rock/Metal 1	Iron Maiden / The trooper	3.46	3.98	5.01	4.91	2.61	3.08	3.48	3.60	4.91	4.60	4.67	5.00
Rock/Metal 2	Metallica / Master of puppets	3.49	3.14	4.30	4.59	2.61	2.70	2.89	3.28	3.91	4.40	5.05	5.35
Rock/Metal 3	Slayer / Angel of death	3.06	2.71	4.56	3.98	2.50	2.30	2.84	2.63	3.85	4.10	4.85	5.25
Rock/Metal 4	Slipknot / Psychosocial	2.71	3.56	3.87	4.68	2.20	2.63	2.71	3.40	3.79	4.55	4.58	4.60
Rock/Metal 5	Judas Priest / Painkiller	2.93	3.28	4.35	4.24	2.28	2.59	2.85	3.13	3.75	4.50	4.55	4.80

Appendix C. The results of ANCOVA in Experiment 2.

To investigate whether music familiarity might explain the findings reported in Experiment 2, an analysis of covariance (ANCOVA) was conducted in order to assess the effects of music genre (Jazz, Classical, Rock/Metal, Hip-hop), food type (healthy, indulgent), and taste/flavour (sweet, savoury) on food preference with familiarity as a covariate. The results of the ANCOVA revealed a significant three-way interaction between music genres, food types, and taste/flavour. By splitting the data into savoury and sweet foods, the interaction between music genres and food types was further explored.

In the case of savoury foods, an interaction between music genres and food types was observed. The results of pairwise-comparison revealed that listening to Jazz, Classical, and Hip-hop music increased the participants' preferences for healthy savoury foods as compared with listening to Rock/Metal (all adj. ps < .05). Additionally, listening to Hip-hop music increased preferences for indulgent savoury foods as compared with listening to the other music genres (all adj. ps < .05). For sweet foods, a main effect of music genre was observed. There was no interaction between sounds and food types. The main effect of music genre revealed that listening to Classical music increased preferences for sweet foods as compared with the other music genres (all adj. ps < .05). Jazz also increased preferences for sweet foods as compared with Rock/Metal (adj. p = .003).

Appendix Table C. Summary of ANCOVA Results in Experiment 2

4 music genres × 2 Food types × 2 Taste/flavour	Type III SS	df	Mean Square	F	P	η_p^2
Music genre × food type × taste/flavour	18.414	3	6.14	14.77	< .001	0.101
Savoury foods						
Food types	13.233	1	13.2	20.03	< .001	0.048
Music genre × food types	38.782	3	12.9	19.56	< .001	0.13
Sweet foods						
Food types	9.681	1	9.68	22.29	< .001	0.054

Music genre × food types	0.426	3	0.14	0.327	.806	0.002
Indulgent savoury foods						
Music genres	36.982	3	12.3	8.045	< .001	0.058
Healthy savoury foods						
Music genres	26.471	3	8.82	6.629	< .001	0.048

Appendix Table C. Statistical summaries of pairwise comparisons. Influence of music genres, food types, and taste/flavour on valence and arousal.

Experiment 1				**Experiment 2 (Pre-registered replication)**			
Valence				*Valence*			
Pair	Diff	t-value	adj. p	Pair	Diff	t-value	adj. p
Jazz > Rock/Metal	0.881	5.302	<.001	**Classical > Rock/Metal**	0.631	3.791	.001
Classical > Rock/Metal	0.860	5.163	<.001	**Jazz > Rock/Metal**	0.511	3.101	.011
Jazz > Hip-hop	0.610	3.639	<.001	Hip-hop = Rock/Metal	0.328	1.973	.151
Classical > Hip-hop	0.590	3.506	.015	Classical = Hip-hop	0.304	1.819	.211
Hip-hop = Rock/Metal	0.270	1.614	.215	Jazz = Hip-hop	0.184	1.111	.531
Jazz = Classical	0.021	0.125	.915	Jazz = Classical	-0.120	0.725	.531
Arousal				*Arousal*			
Rock/Metal > Classical	2.429	12.574	<.001	**Rock/Metal > Classical**	2.816	14.562	<.001
Hip-hop > Classical	1.996	10.228	<.001	**Hip-hop > Classical**	2.271	11.712	<.001

Rock/Metal > Jazz	1.463	7.589	<.001	**Rock/Metal > Jazz**	1.863	9.728	<.001
Hip-hop > Jazz	1.029	5.287	<.001	**Hip-hop > Jazz**	1.317	6.862	<.001
Jazz > Classical	0.967	4.992	<.001	**Jazz > Classical**	0.954	4.955	<.001
Rock/Metal > Hip-hop	0.433	2.231	.026	**Rock/Metal > Hip-hop**	0.546	2.828	.005

Note: Bold denotes significant difference (adj. $p < .05$ with Shaffer's modified sequentially rejective Bonferroni procedure; Shaffer, 1986).