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Influence of Sound Level on Diners' Perceptions and Behavior in a Montreal Restaurant

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Abstract

This study investigates the effect of ambient sound level on diners' perception and behavior in an upscale restaurant in Montreal. A questionnaire was administered to 247 diners and their behavior (time and money spent) was observed in the restaurant during four consecutive weeks. The questionnaire pertained to the restaurant experience, including satisfaction and perceived conviviality; the sound environment (using the Swedish Soundscape Quality Protocol); and person-related variables, such as noise sensitivity. We ran a *conditional process analysis* to explore how the influence of ambient sound level might be mediated by evaluation of the sound environment, and moderated by noise sensitivity. We observed a significant direct positive influence of ambient sound level on diners' behavior (time and money spent) but no effect on their perception of satisfaction and conviviality. For every decibel increase, time and money spent increased by 3.3 minutes and 2.2$ respectively. Ambient sound level also significantly influenced the perception of the sound environment: as sound level increased, so did the ratings of eventfulness, while ratings of perceived chaos and unpleasantness decreased.

Keywords

Soundscape, noise sensitivity, conviviality, restaurant, consumer perception, consumer behavior

1. Introduction

Converging evidence from different fields of research (e.g. marketing and hospitality, music psychology, experimental psychology) shows that the sound environment influences behavior in a wide range of contexts, including psychosis symptoms [1] and shopping behavior [2]. Music plays an important role in the overall sonic environment and can be used to design or modulate the soundscape. Coined by Schafer [3], the term *soundscape* was recently defined by the ISO as the "acoustic environment as perceived or experienced and/or understood by a person or people, in context" [4].

1.1. Restaurant soundscapes

While most soundscape studies have focused on outdoor urban environments, researchers have shown a growing interest recently in the soundscape of indoor spaces, ranging from well-being in care facilities [5] and residential buildings [6] to performance in offices [7], acoustic comfort [8,9] and space usage [9] in libraries, and service quality in commercial premises [10], such as restaurants and cafés [11–13] (see [14] for a recent review of auditory influences on food perception and consumer behavior). This growing interest is also leading to the development of frameworks and questionnaires for indoor soundscape studies [9,15].

In the context of restaurants, the sound of other people talking is a major element of the soundscape. Contrary to external sound sources (such as music), conversations cannot be directly controlled but the well-known Lombard effect [16] – in which people raise their voice in response as a function of the level of ambient noise – implies that controlling the acoustical parameters of the space can modulate the noise level of conversations. Controlling ambient noise level not only improves the auditory quality of the environment, but also reduces vocal strain. Rindel [17] suggested a simple prediction model of the sound level of a restaurant based on the Lombard effect, group size, and sound absorption, added to the more conventional factors of room volume, reverberation time, and number of people. He later derived a measure of "acoustical capacity," following results obtained with this model, to establish the number of people above which the quality of verbal communication would be insufficient [18]. However, Rindel's model and measures do not account for the presence of sounds other than people talking, but rather focuses on the "best-case scenario" for speech intelligibility.

Historically, music has been studied as an important but easily controlled sound source in the context of commercial spaces. It was found to have a significant positive effect on mood [19] and perceived soundscape pleasantness [20], and to be correlated to a higher acoustic comfort in large dining spaces [13].

Soundscape evaluations are influenced by person-related factors, including personality traits and noise sensitivity [21], by properties of the sonic environment [12], including sound level and sound sources [11], and by the activity being performed [22] or envisaged [23]. Where restaurants are concerned, the activity revolves around eating. However, the appropriateness of the soundscape may have less to do with the activity itself than with the establishment's image as determined by restaurant type, target audience and ambience.

The first studies of the influence of sound on consumers focused on tempo and sound level of background music. Milliman [24] observed that diners stayed longer and consumed more alcoholic beverages in an upscale restaurant when the background music had a slow tempo. He concluded that the slower tempo created a more relaxing environment, which led to increased approach behaviors (time and money spent). Similarly, other studies found that a faster tempo increased eating speed [25] and drinking speed [26].

In a laboratory experiment, McCarron and Tierney [27] found that soft drink consumption increased with loudness of music. In a more ecological setting, Guéguen, Le Guellec, and Jacob [28] found that patrons bought significantly more drinks under a higher sound level in French bars. Music loudness also increased satisfaction of shopping experience directly, and approach behaviors (time and money spent) indirectly through arousal and pleasure, in a fashion retail setting targeting younger people [29]. The fact that people made healthier choices of food under lower background music and noise levels has been interpreted as a consequence of higher relaxation induced in shoppers; and therefore, as evidence in support of the hypothesis that the influence of sound level on consumption behaviors is mediated by arousal [30].

Additionally, softer music can increase meal duration and expenditure in restaurants, which could be explained by soft music fitting the expectations of restaurant patrons better than loud music [31,32]. Additionally, Maruyama et al. [33] found that a combination of high sound level and higher density of seat occupation had a negative effect on acoustic comfort in a café, in relation to ease of conversation and hearing difficulty. More specifically, the combined sound level of background noise and music in a restaurant elicits the highest level of pleasure when it is at a level that allows diners to communicate with the people at their table; and a higher level of pleasure from the experience leads to increased behavioral intent (willingness to stay longer and pay more, and intention to return and to recommend to others [34]). Similarly, background music was found to considerably improve the evaluation of pleasantness, conviviality and eventfulness by drawing new people to an urban park and encouraging interaction [35]. In light of this, we wanted to explore conviviality as a function of background music in the context of

restaurants, with the hypothesis it may tie in the different factors influencing approach behaviors.

1.2. Conviviality and ambiance

Conviviality is a commonly understood and casually used concept in French, but more elusive in English. It is associated with sociability and hospitality, often in contexts involving food [36], but not only [37]. Illich's definition of conviviality, although broader, includes the idea that it is "autonomous and creative intercourse among persons, and the intercourse of persons with their environment" [38]. Our team found that conviviality, defined as such, is a factor in the judgment and approach behaviors of park users [35]. In the context of a restaurant, conviviality relates to the perception of being in good company and of interacting with one's companions. It can even be elicited with strangers, such as when a whole restaurant starts singing "Happy Birthday" [39], or in the context of eating in the dark [40]. Previous work indicates that eating together and eating out contribute to the sense of conviviality [36]. As such, it is valid to enquire as to the role of the sound environment in restaurants on patrons' perception of conviviality.

Although the influence of the sound environment on conviviality in restaurants has rarely been studied directly as such, the genre of background music has been shown to influence the perception of restaurant image and ambience [41,42], which can be argued to be necessary conditions for conviviality. In turn, restaurant image and ambiance influenced consumer behaviors, including time and money spent [41,42]. North and Hargreaves found that, in classical and pop music conditions, participants were willing to pay more for suggested food items (intended behavior) and they observed a tendency for increased sales (actual behavior) when background music was manipulated [41]. In the classical music condition, the cafeteria in question was perceived as more sophisticated, feminine and sensual, and less down-market. In the pop condition, the cafeteria was perceived, instead, as more exciting, happy, youthful and less peaceful. Similarly, Wilson found that a restaurant was perceived as least upbeat with no background music, as most upmarket/sophisticated with classical music, and as most upbeat with pop music [42]. It is important to note that the restaurant in question was perceived as more down-market and tacky when the music was not deemed appropriate.

In sum, background music influences our evaluation of the environment in general. Additionally, it needs to be context appropriate (i.e. fit the activity envisaged and/or the establishment's image). Typically, soundscape studies have been conducted either in ecological and outdoor settings or in indoor environments such as research labs and businesses other than restaurants. Most studies on sound in restaurants are

conducted in experimental settings using participants recruited specifically for the study, allowing for controlled manipulations of the sound environment. However, the few studies carried out in restaurants suggest that music influences perceived restaurant image and diner behavior. We thus chose to conduct our study in ecological settings with diners recruited in a restaurant, in an attempt to bring together academic soundscape research and the professional hospitality industry.

1.3. Study hypotheses

We undertook a study to further examine the influence of the sound level and genre of background music and overall soundscape on diners' perceptions in a restaurant. Based on the literature, we hypothesized that a music level and a music genre deemed inadequate for the dining setting would negatively impact diners' perceptions.

We manipulated the music level and genre of the music, in collaboration with the staff. However, due to the ecological settings of the study, the manipulations of music level could not be controlled too rigorously. Indeed, the staff often had to adjust the music level at the request of diners, and changes in occupancy resulted in large variations in sound level. In addition, the manipulation of music genre was also limited to genres deemed appropriate by the staff (see Table 1). As a result, the sound levels averaged by condition (see section 2.5) did not match the envisaged research design (see Figure 4). For example, while significant differences were observed across conditions, the average sound level for week 3 (when we lowered the music level) was higher than for week 1 (pre-intervention condition).

We therefore adapted our hypothesis: a higher sound level positively influences a diner's evaluation of the restaurant in terms of satisfaction with their experience and conviviality of the restaurant's ambiance, and diner behavior in terms of time and money spent in the restaurant. We also investigated the contrast of the behavioral results (time and money spent) compared to the perceptual results (satisfaction and conviviality), as well as the two perceptual results between them.

Furthermore, the majority of studies on the influence of the sound environment on consumer perceptions and behaviors have looked at variables in varying degrees of isolation. Some models exist, based on a review of the available literature, of the influence of the sound environment on approach behaviors in service settings. For example, Harrington et al. [43] tested a model of the influence of age on consumer behavior (total spending, intent to return) mediated by overall atmosphere perception and mediated by

music tempo and level in a casual restaurant, based on Oakes' musicscape framework [44]. They found that, as age increased, atmosphere perception and intent to return decreased, while total spending increased. This influence of age on atmosphere perception was moderated by music tempo and level. Additionally, a higher tempo and a lower level increased total spending directly but had no influence on intent to return. However, they tested a limited number of the relationships proposed in the musicscape model, using the Baron and Kenny method [45]. A number of concerns with this approach have been raised [46], such as low statistical power and lack of quantification of the mediation effect.

We wanted to conduct an exploratory analysis of the relationships between our variables, looking at the paths of influence of the sound level on the outcomes we measured diners' evaluation and behavior. We hypothesized that the influence of sound level on these outcomes would be mediated by the participants' perceptions of the sound environment, as well as moderated by personal and situational factors (namely, noise sensitivity and the number of people in their group). In light of the concerns with the Baron and Kenny method, and in order to integrate both mediation and moderation in our model, we used Hayes' *conditional process analysis* [46] to explore how the influence of sound level on diner satisfaction, diner perception of conviviality, and time and money spent in the restaurant, might be mediated by diner evaluation of soundscape, and moderated by the person-related factor of noise sensitivity, and the situational factor of the number of people eating at the table.

2. Methods

We conducted an exploratory analysis, in multiple steps, of the influence of sound level on our 4 main outcomes (diner satisfaction, diner perception of conviviality, time spent, and money spent in the restaurant), mediated by diner evaluation of 7 scales from the Swedish Soundscape Quality Protocol (SSQP) [47], and moderated by noise sensitivity and number of people at the table. A summary of the statistical analysis performed in each step in this paper is available in Table 1, while more details can be found in section 2.6.2.

Table 1. Summary of the statistical analyses

Section	**Method**	**Variables**			
		Independent/ Predictor	**Dependent**	**Mediator**	**Moderator**
3.2	ANOVA	• Conditions • Times of day	• Sound Level		

		• Weighting			
3.3.1	Multiple Regression	• Sound Level	• Satisfaction • Conviviality • Time Spent • Money Spent		
	Bivariate Correlation	• Number of people at table	• Sound Level • Time Spent • Money Spent		
3.3.2	Mediation Analysis	• Sound Level	• Satisfaction • Conviviality • Time Spent • Money Spent	• SSQP: {pleasant, unpleasant, eventful, vibrant, monotonous, calm; chaotic} • Other: {soundscape appropriateness; perceived sound level; music pleasantness}	
3.3.3	Conditional analysis	• Same as 3.3.2	• Same as 3.3.2	• Same as 3.3.2	• Noise sensitivity • Number of people at table

2.1. Participants

Diners were approached at the end of their meal to complete a questionnaire in return for a small gift worth approximately CA$5 (jar of chutney or chocolate sampler). Of the 247 who agreed (140 women), 216 were French-speaking and 31 were English-speaking. Their mean age was 52.7 years (*SD* = 16.0). The study took place at the Restaurant de l'Institut de Tourisme et d'Hôtellerie du Québec (ITHQ), the commercial restaurant of a culinary school in Montréal, in Montreal, Canada, in the summer of 2015, over a four-week period (about 60 participants per week).

2.2. Acoustical measurements

The acoustic environment was recorded with a Zoom Q3 calibrated in the laboratory. This calibration was conducted by recording a reference sound in a semi-anechoic room, simultaneously checking the sound level with a sound level meter, in order to calculate a difference factor in decibels to be able to compensate any subsequent calculation of sound level from a recording with this device. The Zoom Q3 does not have an omnidirectional microphone but we considered the field in such a reverberant space to be diffuse enough for the directivity to be irrelevant. The recorder was set on a high gain and recorded in the mp3 format at a bit rate of 320 kbps. It was placed on its side atop the wine cellar (of a height of 2.90 m) in the corner farthest from the entrance in such a manner that the microphones would be minimally shielded by the

surface it sat on. The recording location was in a central position in the restaurant, at a 45° angle facing the L-shaped room (described in section 2.3).

We calculated the average decibel level over a five-second time period ($L_{eq,5sec}$) every five seconds (with no overlap) in MATLAB. We analyzed the $L_{eq,5sec}$ from each recording during the busiest part of the meal. We determined the window of analysis for each dining service based on both conversations with staff and experimenters' observations. The sound level was calculated every five seconds from 12:30 to 14:00 at lunchtime and from 19:30 to 21:30 at dinnertime.

2.3. Restaurant

The restaurant (see Figure 1) had high ceilings (height of 4.80 m) and many reverberant surfaces (with an reverberation time of 1.2 s). It featured high windows with wood or mirror blinds and wooden walls and floor, with no acoustical treatment. Tables were made of wood and metal and covered with heavy tablecloths. Chairs were made of wood with a thick leather cushion.

The restaurant was equipped with 10 loudspeakers JBL Control® 25T, suspended from the cement ceiling. They were connected to a 5-CD player Yamaha CDC-685 via a mixer/power amplifier TOA A-512A.

We calculated the acoustical capacity of the restaurant, defined as a measure of the maximum number of people in a room (N_{max}) under which verbal communication is of sufficient quality [18] and estimated as follows: $N_{max} = V/20T$, where T is the reverberation time at mid frequencies [500 – 1000 Hz] and V the room volume. The acoustical capacity of the restaurant is 46, which is much lower than the full restaurant capacity (N = 65). The number of diners during the experimental conditions range between 13 to 33 at lunch and 28 to 45 at dinner, resulting in a (N/N_{max}) ranging from 0.3 to 0.7 for lunch, and 0.6 to 1.0 for dinner. This corresponds to verbal communication conditions ranging from satisfactory to just sufficient, according to Rindel's predictions [18], which doesn't take into account any additional sounds, such as background music.

Figure 1. Panoramic picture of the Restaurant de l'ITHQ, facing the wine cellar, the windows behind the photographer can be seen along the left edge of the picture and the entrance is at the far end on the right. The recorder was placed atop the cellar (red cross).

2.4. Measured outcomes

Two measures of behaviors were based on the restaurant's records: time and money spent in the restaurants. For standardization, duration of stay was calculated as the difference between time of order and time of billing, as appearing on order tickets and bills, respectively. Money spent was gathered from bills, divided by the number of people at the table, as the restaurant offered a fixed-price menu over the summer (see section *2.5* below).

A questionnaire was designed to assess participants' dining experience, soundscape judgments, and person-related factors (see *Appendix A* for full questionnaire). It required less than 10 minutes to complete, and was constructed from a number of validated protocols and scales available in English: the SSQP [47], the shortened version of Weinstein's Noise Sensitivity Scale (NSS – a higher score indicates a higher sensitivity) [48,49], the extraversion item from the five-item personality inventory [50]; as well as additional questions pertaining to relevant dimensions (i.e. sociodemographic, music perception, dining experience). The question on conviviality was added to explore the potential contribution of this under-investigated factor of social experience. Person-related factors include demographics like gender, age, number of years they have been living in Montreal or where they live outside of Montreal, and situational factors include the number and type of people they are eating with.

A French version of the questionnaire was developed to give participants the choice of completing the instrument in either of the two official languages in Montreal. The French translation of the NSS was

validated using principal component analysis (PCA) and was found to yield components similar to those of the English version [51].

In this article, we only show the analysis of the influence of sound level on the two behavioral outcomes of time and money spent in the restaurant, and the two perceptual dependent variables of satisfaction and conviviality; directly and indirectly through the perception of the sound environment (SSQP ratings, soundscape appropriateness, perceived sound level, and music pleasantness). This article also explores the open-ended questions on sound sources and the free comments to inform the quantitative results.

2.5. Study conditions

The restaurant proposed the same set-price menus in the summer for each meal every day of the week. The study was conducted at two times of day (i.e. different meal settings) selected after consulting with staff: weekday lunchtime, when we expected more local working people eating with colleagues and, potentially, clients; and weekend dinnertime, when the patronage was more diverse and included summer tourists.

The experiment was carried out over four weeks. The first week served as the "pre-intervention" condition, to measure the restaurant usual attendance and music choices without any experimental changes. Music level during the second and third weeks was increased and decreased, respectively, while keeping the same playlists as in the pre-intervention condition, in an attempt to create a *louder* and a *quieter* conditions, respectively. The music genre was manipulated during the fourth week only, while keeping the same level as in the pre-intervention condition, for our *novel* condition (see Table 2).

We worked with staff to establish the commercial playlists they generally used and to choose novel ones. For the first three conditions (pre-intervention, louder, quieter), the same two playlists were used throughout the weeks, one for lunchtime and one for dinnertime. For the fourth condition (novel), two novel playlists were chosen, one for lunchtime and one for dinnertime. Songs were played in random order within all playlists. The four chosen playlists didn't vary significantly in average song duration and tempo (see Table 2).

Table 2. Overview of study conditions with presented genre, mean tempo in beats per minute (BPM), and total duration of the playlists chosen by the restaurant staff. The playlists in the pre-intervention

condition (week 1) were also used during the louder and quieter conditions (weeks 2 and 3). Only the novel condition (week 4) saw a change in playlists.

	Lunch			**Dinner**		
	Genre	BPM mean (SD)	Total Duration	Genre	BPM Mean (SD)	Total Duration
Pre-intervention	Pop/Folk	110 (24)	3h 51	Acoustic Pop	119 (30)	3h 23
Novel	Americana	114 (27)	5h 13	Pop	118 (22)	4h 05

2.6. Data analyses

Statistical analyses were conducted with Microsoft® Excel® 2013, R version 4.0.0 and Rstudio version 1.2.5042 for Mac, and IBM® SPSS® version 24. The level of statistical significance was set at $p = .05$. Missing values for questionnaire variables (3.0%) were imputed with the variable mean.

2.6.1. Analysis of audio recordings

We analyzed the audio recordings using the $L_{eq,5sec}$ and $L_{Aeq,5sec}$ at the busiest moment of each mealtime by conducting a 4 (conditions 1 to 4) x 2 (times of day: weekday lunchtime versus weekend dinnertime) x 2 (weightings: dB and dBA) between-participants ANOVA.

2.6.2. Quantitative analyses

The influence of measured sound level on the outcomes of the restaurant experience for the diners (satisfaction, conviviality, time spent, and money spent) was analyzed with multivariate regression analysis. To check for an influence of the number of people at the table on money and time spent in the restaurant, we calculated Spearman correlations between measured sound level, time spent, money spent, and number of people at the table.

We also took a closer look at the variables through which sound level influenced the measured outcomes with mediation analyses with ordinary least squares path analysis using Hayes' PROCESS macro for SPSS v.3 [46]. Mediation analysis tests a hypothetical causal chain where a variable X affects a second variable M which, in turn, affects a third variable Y. M is a *mediator* of the influence of X on Y. The effect of X on Y is an indirect effect through M. The regression coefficient for the relationship between X and M is labeled a (in our case, a_i for each M_i), and the regression coefficient for the relationship between M and Y is labeled

b (b_i for each M_i), while the regression coefficient of the direct effect of X on Y is c'. We tested the indirect effects of measured sound level on time spent, money spent, conviviality, and satisfaction in four different mediation models, as mediated through 10 soundscape judgments: the 7 SSQP ratings (pleasant, unpleasant, eventful, vibrant, monotonous, calm, chaotic), soundscape appropriateness, perceived sound level, and music pleasantness (see Figure 2 for time spent).

We followed up with conditional process analyses, using the same macro and path analysis, exploring the addition of two moderators on all the paths of the mediation models: the person-related factor of noise sensitivity, and the contextual factor of number of people at the respondents' table (see Figure 9 in *Appendix B*). Moderation analysis tests for the influence of a *moderating* variable, Z, on the effect of X on Y. It tests when or under what conditions an effect occurs. A moderator is not hypothesized to have a causal link between the other variables X and Y, but to modify the nature of the relationship between X and Y.

2.6.3. Qualitative analysis

The qualitative data obtained on the open-ended sound sources question were categorized and analyzed with descriptive statistics and nonparametric chi-squared tests of homogeneity of proportions. Verbal descriptors for each category (pleasant, unpleasant, neutral) were grouped into emerging themes using the constant comparison method [52]. Occurrences within each theme were summed across all participants.

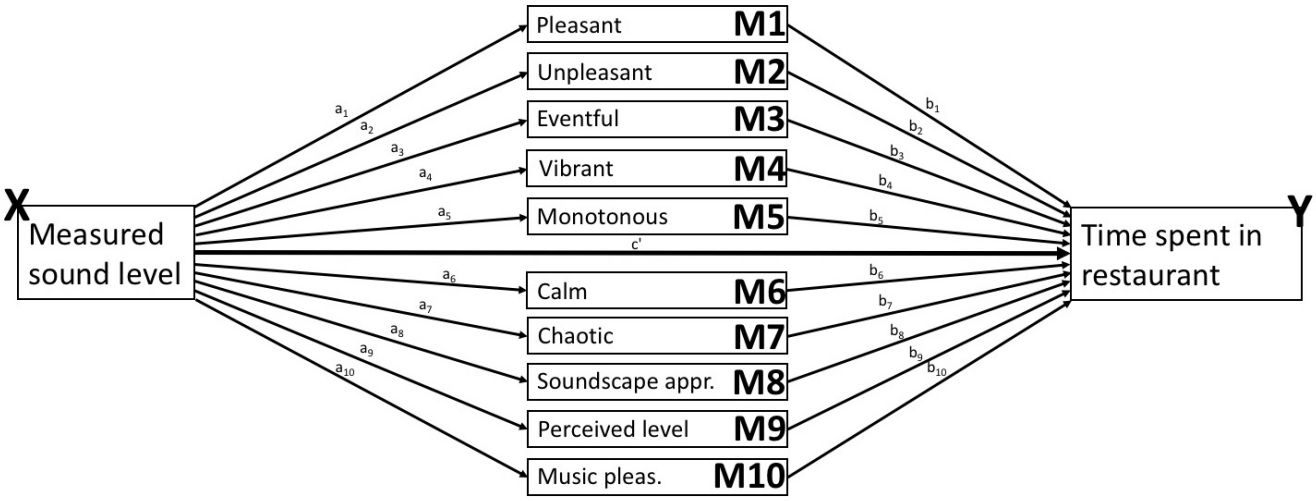

Figure 2. Exploratory model of the effect of measured sound level (X) on the time participants spent in the restaurant (Y), mediated by 10 variables (M_i). Other models explored the effect of the measured sound level (X) on money spent, participant satisfaction and perception of conviviality (Y), keeping the same mediators. This represents 4 models in total. The regression coefficient of the direct effect is noted c', while the coefficients for each influence of X on the M_i mediators are noted a_i, and each influence of the M_i mediators on Y are noted b_i.

We also categorized the responses in the comment box (n = 130), on which we did not conduct any statistical analyses, due to the small number of responses pertaining to sound (n = 37).

3. Results

3.1. Descriptive statistics

Participants' age (M = 53.4, SD = 16.2 was significantly different ($p < .01$) only in the last week (M = 48.3, SD = 17.4) compared with the first week (M = 59.1, SD = 13.1). However, the person-related factors of years lived in Montreal (M = 31.2, SD = 22.5), NSS score (M = 12.8, SD = 4.2; range of -1 to 19), and extraversion (M = 3.6, SD = 1.1 on a 5-point Likert scale) showed no differences across weeks or any association between one another. Other ratings were averaged over the four weeks (see Figure 3 for means and standard deviations per condition).

3.2. Analysis of audio recording

The ANOVA revealed significant differences between the sound levels across all conditions ($F(3,31139) = 5871$, $p < .0001$), times of day ($F(1, 31139) = 11012$, $p < .0001$), and weighting ($F(1, 31139) = 6908$, $p < .0001$), as well as an interaction between conditions and times of day ($F(3, 31139) = 1341$, $p < .0001$; see Figure 4). Tukey HSD post-hoc tests showed that the conditions ranked from low to high for measured

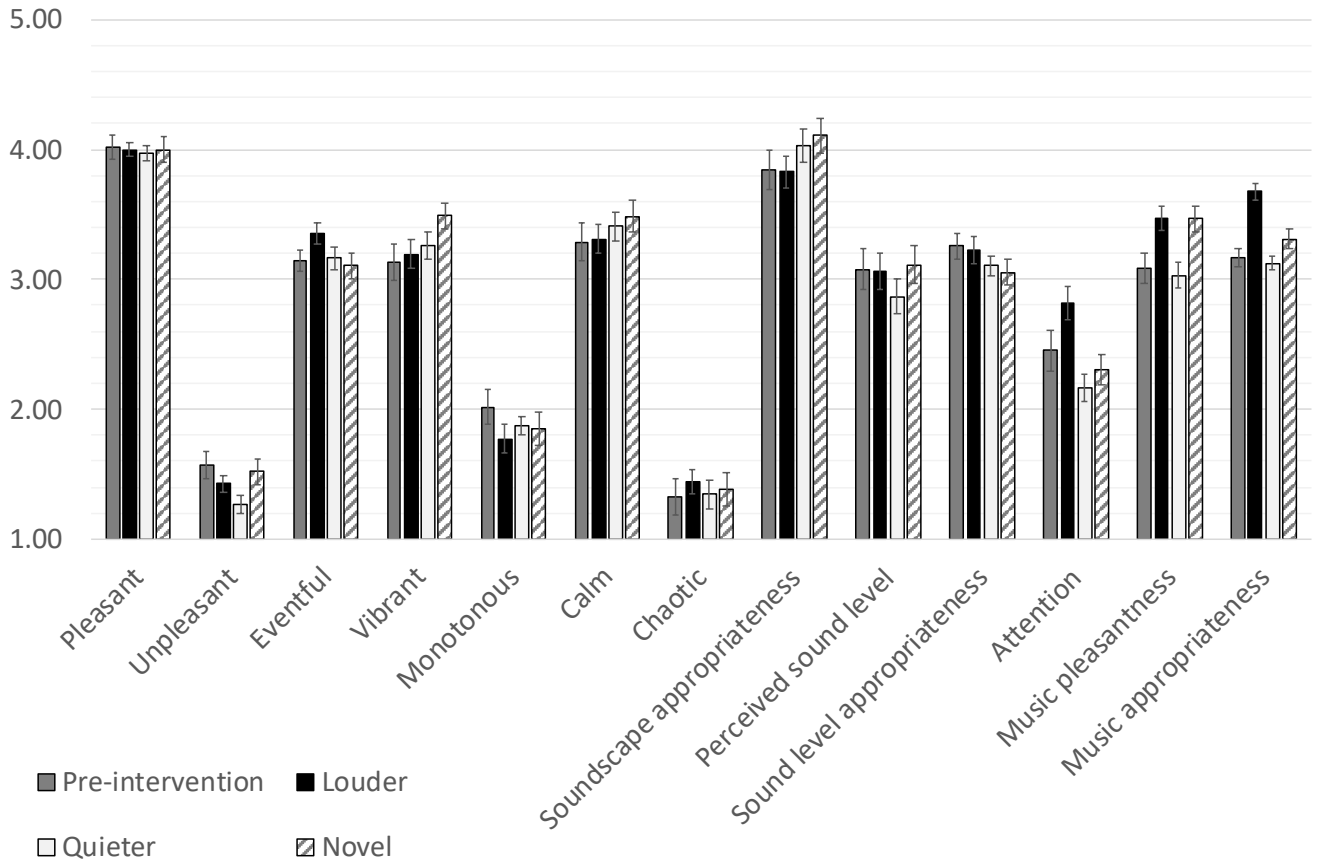

Figure 3. Mean and standard deviation by condition for the 13 sound-related variables. Dark grey bars show the pre-intervention condition (first week), black bars the higher music level condition (second week), light grey bars the lower music level condition (third week), and hash patterned bars the novel playlist condition (fourth week).

sound level as follows: condition 1, *pre-intervention*, (M = 70.93 dBA; SD = 3.31 – M = 73.62 dB; SD = 2.86), condition 3, *quiet*, (73.39 ± 4.40 dBA – 75.14 ± 3.89 dB), condition 4, *novel*, (73.76 ± 2.46 dBA – 76.15 ± 2.19 dB), and condition 2, *loud*, (76.07 ± 3.65 dBA – 78.65 ± 3.20 dB). Additionally, lunchtime (71.25 ± 3.66 dBA – 74.09 ± 3.21 dB) was quieter than dinnertime (74.85 ± 3.91 dBA – 77.33 ± 3.59 dB). And, as expected, dB levels (75.90 ± 3.79) are higher than dBA levels (73.17 ± 4.20). Measured sound level was positively correlated (R = .611, p < .0001) with number of patrons in the restaurant.

The sound level in the restaurant at mealtime as recorded from the position of the microphone ranged from 58 to 89 dBA (62 to 91 dB). Means ranged from 70 to 78 dBA (73 to 81 dB). These values are comparable to the range of 60 to 80 dBA observed in restaurants in New Zealand and the United States [53], as well as Singapore [12]. When collapsed over time of day, the sound level was lowest during the first week (pre-intervention condition) followed by, in increasing order, the quieter, novel, and louder conditions. One

explanation for this might be that there were fewer diners present the first week (see section *3.3.1*). Lunchtime was quieter than dinnertime, which reflected the number of patrons in the restaurant and the type of ambience desired. Unweighted and A-weighted levels consistently evolved in the same direction, so we decided to rely on the unweighted levels only for subsequent analyses (see Figure 4).

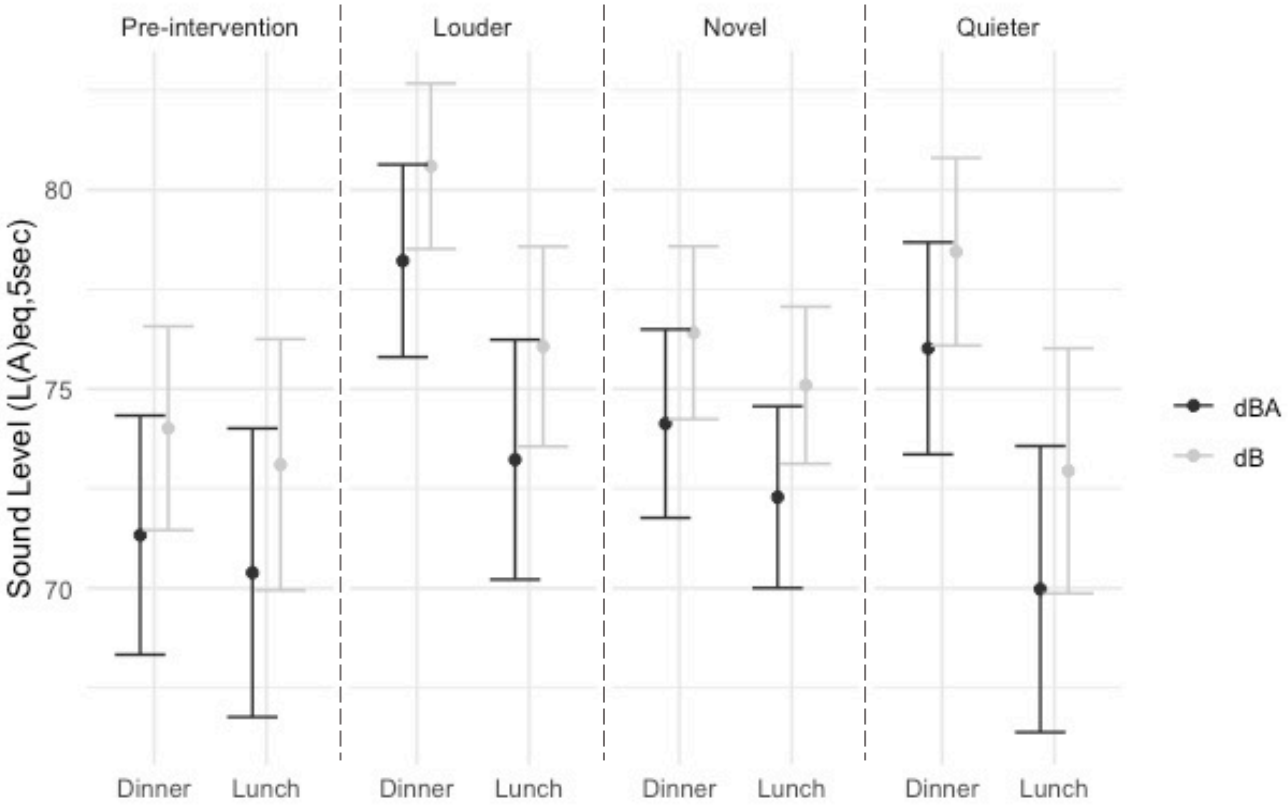

Figure 4. Mean and standard deviation of sound levels ($L_{(A)eq,5sec}$) for each condition and time of day (in dB and. dBA). Significant effects of condition and time of day were observed ($p < .0001$).

3.3. Quantitative analyses of questionnaire data

3.3.1. Direct influence of measured sound level on time, money, satisfaction, and conviviality

The multivariate regression shows that measured sound level significantly directly influences time spent ($b = 3.195$, $p < .0001$) and money spent ($b = 2.079$, $p < .0001$), but not satisfaction ($b = .017$, $p = .216$) and conviviality ($b = .012$, $p = .425$).

Spearman correlations show a significant moderate positive association of number of people at the table with time spent ($\rho = .388$, $p < .0001$), as well as significant small positive ones with money spent ($\rho =$

.163, p = .010) and measured sound level (ρ = .164, p = .010). In comparison, measured sound level is also significantly and moderately positively correlated to time spent (ρ = .330, p < .0001) and money spent (ρ = .347, p < .0001).

3.3.2. Indirect (mediated) influence of measured sound level on time, money, satisfaction, and conviviality

Figure 2 shows one of the four mediation models. It explores the influence of the measured sound level on the time spent in the restaurant. The other three models explored the influence of sound level on money spent in the restaurant, on satisfaction with their experience, and on perceived conviviality of the restaurant. The mediating variables were the 7 SSQP scales. The model also includes perceived appropriateness of the soundscape, perceived sound level, and perceived pleasantness of the background music (for clarity, only significant results are reported below).

The influence of measured sound level on the mediators (left part of the model) is the same for the four models: as measured sound level increases, eventfulness significantly increases (a_3 = .0493, p = .0216), while music pleasantness tends to increase, too (a_1 = .0440, p = .0763).

Measured sound level also directly positively influences the measured behavioral outcomes of time (c' = 3.2786, p < .0001) and money spent in the restaurant (c' = 2.1782, p < .0001): that is, with an increase of 3.3 min and CA$2.2, respectively. No additional influence from the tested mediators is revealed for amount, but as the calm of the soundscape increases, so does the duration of stay (b_6 = 4.4186, p = .0138), while an increase in soundscape pleasantness tends to reduce that duration (b_1 = -5.4113, p = .0631).

But mediation models for the self-reports reveal no paths of influence on the self-reported outcomes (satisfaction, conviviality) from the measured sound level, whether direct or not. Only soundscape pleasantness influences positively both satisfaction (b_1 = .2393, p = .0004) and conviviality (b_1 = .3171, p < .0001). The soundscape ratings of monotonous (b_5 = -.0710, p = .0729), chaotic (b_7 = .1364, p = .0520), and appropriate (b_8 = .1034, p = .0895) also tend to influence conviviality, revealing a potentially richer picture than for satisfaction.

3.3.3. Indirect (mediated and moderated) influence of measured sound level on time, money, satisfaction, and conviviality

To explore that richer model of influences on conviviality, in comparison to satisfaction, we conducted

conditional process analyses to understand the circumstances under which the effects we saw above occur. We added moderation to all the paths of the previous mediation models: by the diners' self-reported noise sensitivity, and by the number of people eating with them (for clarity, only significant results are reported below). Figure 9 (in *Appendix B*) shows the four models and their significant relationships explained below.

The influence of measured sound level on the mediators and its moderation (left part of the model) is the same for the four models: as measured sound level increases, soundscape ratings of pleasantness increases (a_1 = .1566, p = .0463), while unpleasantness (a_2 = -.2429, p = .0016) and chaoticness decrease (a_7 = -.1472, p = .0244). The influence of measured sound level (SL) on unpleasantness is moderated by noise sensitivity (a_2 = -1.2479 + .0164SL, p = .0016). People who are more sensitive to noise rate the soundscape as more unpleasant when the sound level increases, as opposed to people with lower noise sensitivity who find the soundscape as less unpleasant when the sound level goes up (see Figure 5a). The non-significant influence of measured sound level on monotony is moderated by the number of people at the table (a_5 = .0277, p = .0419). Diners with 1 or 2 other people at the table rate the soundscape as less monotonous when the sound level increases, as opposed to bigger tables whose monotony rating does not change (see Figure 5b). Finally, perceived sound level increases with measured sound level for tables of 2 and 3 (2 more so than 3), but not more (see Figure 5c).

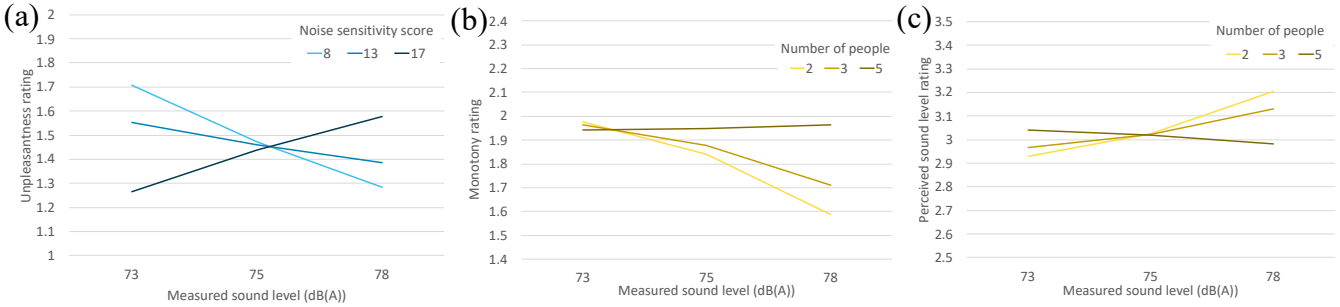

Figure 5. Significant (p < .05) moderations of the influence of measured sound level on the models' moderators. (a) moderation of the influence of sound level on unpleasantness by participant noise sensitivity score. (b) moderation of the influence of sound level on monotony by the number of people at the table. (c) moderation of the influence of sound level on perceived sound level by the number of people at the table.

People who found the soundscape less monotonous spent more time in the restaurant (b_5 =-17.9787, p = .0173). Additionally, the non-significant influence of soundscape appropriateness on time spent in the restaurant is moderated by the number of people at the table (b_8 = 3.9339, p = .0318 – see Figure 6).

When there are more people at the table, the more the soundscape is perceived as appropriate, the more diners linger.

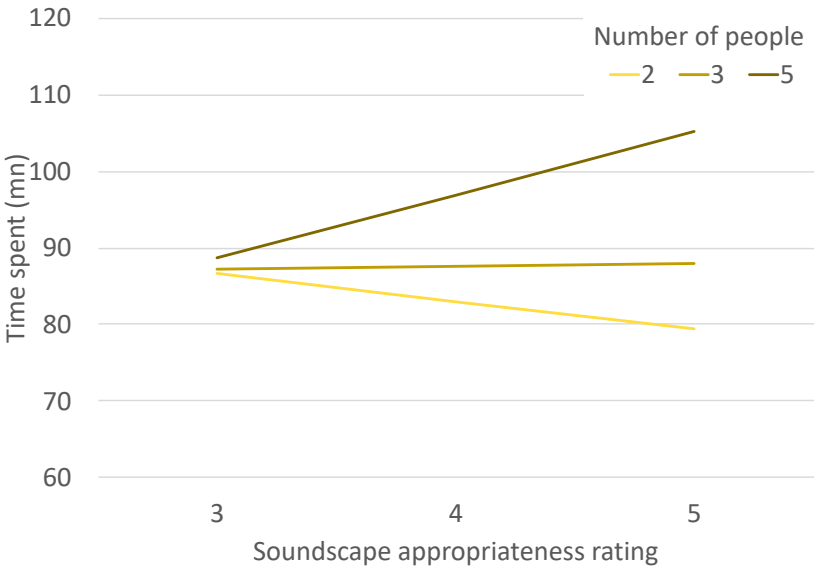

Figure 6. Significant ($p < .05$) moderation by the number of people at the table of the influence of soundscape appropriateness on time spent.

As does the simple mediation model, the conditional process analysis on amount reveals that people spent more under a higher measured sound level (c' = 3.7649, p = .0267), with no significant mediation or moderation involved. However, despite a significant influence of soundscape pleasantness in the simple mediation model on reported satisfaction, the process analysis shows no significant direct or indirect influence of any of the variables tested on satisfaction.

Finally, the less monotonous the soundscape (b_5 = -.3890, p = .0338) and the less pleasant the music (b_1 = -.3246, p = .0436), the more convivial the restaurant is perceived. The influence of music pleasantness is moderated by noise sensitivity (b_{10} = .0320, p = .0031), with people who are more sensitive to noise rating the restaurant as more convivial as they find the music more pleasant (see Figure 7a). In contrast, people who are less sensitive to noise rate the restaurant as less convivial, the more they find the music pleasant. The non-significant influence of soundscape appropriateness on conviviality is also moderated by the number of people at the table (b_8 = .900, p = .0431 – see Figure 7b). When there are more people at the table, the more the soundscape is perceived as appropriate, the more the restaurant is rated as convivial.

3.4. Open-ended questions

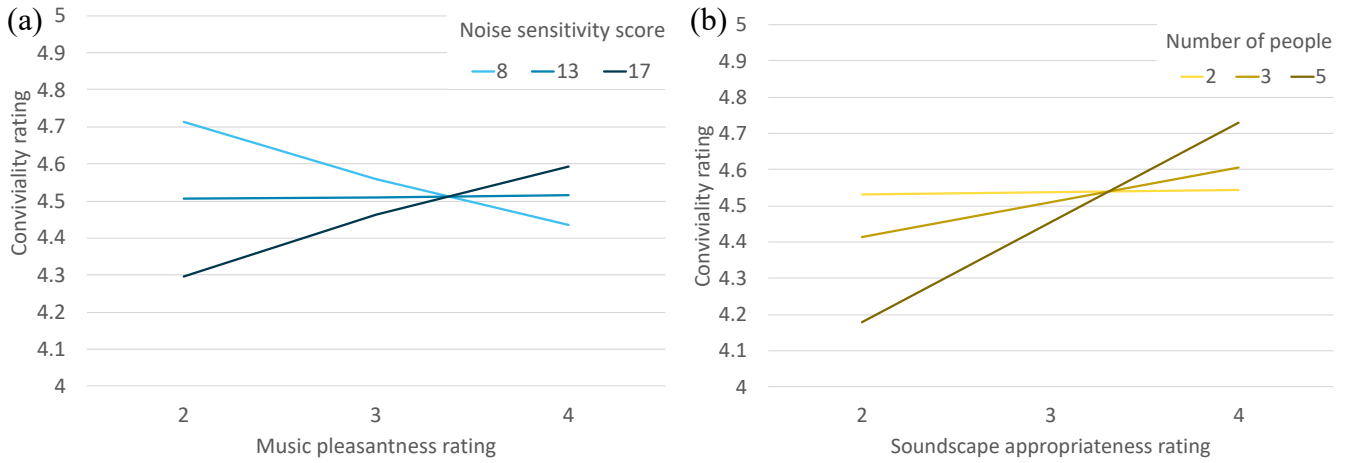

Figure 7. Significant ($p < .05$) moderations of the influence of mediators on conviviality. (a) moderation of the influence of music pleasantness on conviviality by participant noise sensitivity score. (b) moderation of the influence of soundscape appropriateness on conviviality by the number of people at the table.

Regarding the open-ended question on sound sources, we retained only the verbal descriptors with more than ten occurrences (see Figure 8). Four categories stood out: music ($n = 115$) and conversations ($n = 82$) were mentioned most often, followed by the general ambience descriptors pertaining to sound level "loud" ($n = 30$) and "low" ($n = 44$), and finally the location-specific sounds of dishes ($n = 31$), kitchen ($n = 17$) and staff ($n = 13$).

The chi-squared proportion tests (see Figure 8) revealed that the proportion of "music" occurrences was significantly higher ($\chi^2 = 39.083$, $df = 3$, $p < .0001$) in the "pleasant" category (51%) compared with the "unpleasant" (23%) and "neutral" (22%) categories. Similarly, the proportion of "low" occurrences was significantly higher ($\chi^2 = 44.49$, $df = 3$, $p < .0001$) in the "pleasant" category (27%) than in the other two. Conversely, the proportion of "loud" occurrences was significantly higher ($\chi^2 = 58.619$, $df = 3$, $p < .0001$) in the "unpleasant" category (25%) than in the other two. Finally, the proportion of "dishes" occurrences was also significantly higher ($\chi^2 = 27.822$, $df = 3$, $p < .0001$) in the "unpleasant" category (20%) than in the other two.

Music and conversations were the main sound sources noted by the participants in the restaurants, more so than the location-specific sounds expected in a restaurant. This is in line with the literature [11,12,53,54]. Similarly to the much more detailed taxonomy established by Lindborg [11], music was seen as a pleasant aspect of the restaurant's soundscape and conversations were found to be unpleasant as much as neutral/pleasant. This probably depended on the participants' perception of the annoyance level of neighboring tables. Indeed, a number of participants remarked that the distance between tables—further

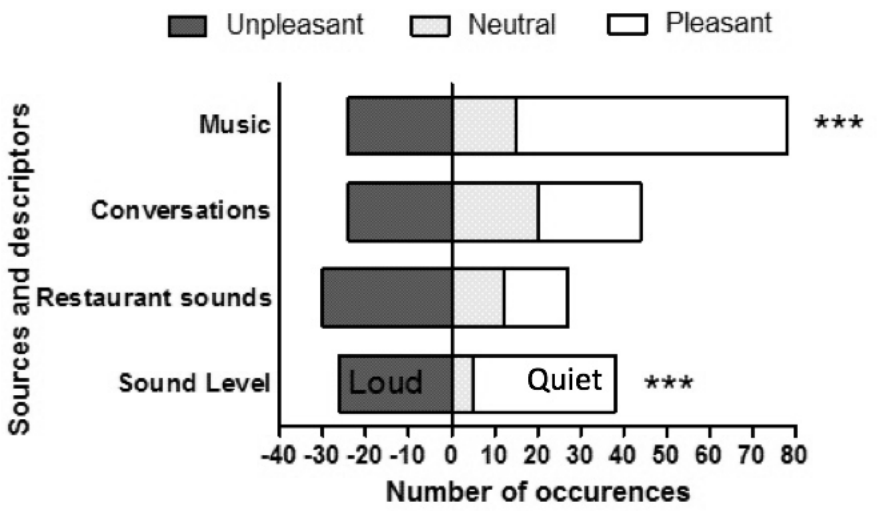

*Figure 8. Occurrences of unpleasant, neutral and pleasant sound sources and ambience descriptors. *** $p < .0001$.*

than usual owing to the training function of the restaurant—afforded greater privacy than usual. This is in line with previous work showing that the sense of privacy in restaurant was correlated to sound level [55]. People also spontaneously used sound level-related descriptors to qualify their sonic environment.

The analysis of optional free-format comments at the end of the questionnaire indicated that 37 participants are concerned about the sound environment in this restaurant, some even offered suggestions as to how to improve it in this particular restaurant or more generally in Montreal.

3.5. Summary

Regarding the effect of ambient sound level on approach behavior, for every decibel increase, time and money spent increased by respectively 3.3 minutes and 2.2$. And for the influence of sound level on soundscape assessments, as sound level increased, so did perceived eventfulness by .16 scale unit for each decibel, while perceived chaos decreased by .15 scale unit and unpleasantness by .24 scale unit. The latter depends on noise sensitivity: an increase in sound level is perceived as more unpleasant by more sensitive people and less unpleasant by less sensitive people.

Regarding the influence of soundscape assessments on the four measured outcomes (satisfaction, conviviality, time, money), we see that, for each unit of increase in monotony, duration of stay decreases by 18 minutes, and perceived conviviality of the restaurant decreases by .39 scale unit.

4. Discussion

The objectives for our study were to apply soundscape research to an indoor environment, and to help our commercial partner understand and improve the restaurant's soundscape. Being exploratory in nature, the study considered a large number of variables. To this end we measured the sound level of an upscale restaurant over 4 weeks, during which we measured diners' behavior in terms of time and money spent. We also measured diners' satisfaction and perceived conviviality, as well as soundscape judgments (pleasant, unpleasant, eventful, vibrant, monotonous, calm, chaotic, appropriate), perceived sound level, and music pleasantness (see *Appendix* for full questionnaire).

Satisfaction, and time and money spent are commonly used in hospitality and marketing research. But, to the best of our knowledge, conviviality has never been used as a measure of dining experience, despite some work on the associations between eating out and conviviality [36]. The lack of conceptualization of conviviality as a hospitality outcome may result from the fact that it is not a commonly understood and used term in English, as opposed to French.

Even though the results of our multivariate regression did not show a significant difference in experience satisfaction and restaurant conviviality, a significant positive effect of sound level was found on the amount of money participants spent in the restaurant and the duration of their stay (shown to not be fully explained by the number of people at the table with the Spearman correlations). For each decibel of increase, people spent 3.3 min and CA$2.2 more in the restaurant, in the range of sound levels investigated in this study.

This is in line with the literature showing approach behaviors increase with music loudness in bars and shopping center [28,29]. However, other studies in restaurants found that people stay longer and spend more when the music is softer [31,32]. Based on the comments of some of our participants, we hypothesize that our result (increase in approach behavior under increased sound level) is due to the restaurant's sound environment being perceived as quieter than other restaurants. This result suggests that there is an optimal range of perceived sound level. Below a certain level, privacy might be comprised, as you can hear conversations from other tables. Above a certain level, the vocal and listening effort required might also discourage conversation. Meng et al. [56] found that the average frequency of conversation significantly increases when background music is played, compared to no music. They also found that acoustic comfort increases when music is played compare to no music, like Chen and Kang [13], but only up to a certain

crowd density (.23 persons/m^2), over which acoustic comfort is lower in the presence of music than with no music.

A lower ability to communicate between people at the same table has been correlated to lower satisfaction and lower levels of approach behavior, including time and money spent [34]. It seems plausible that the perception of conviviality would also be impacted by the ability to communicate with the other people at one's table, in terms of both attentional and vocal effort. As a future step, we would like to investigate vocal and listening efforts in the same restaurant environment.

Additionally, the significant effect of measured sound level on behaviors (money and time spent), but not on self-reports (satisfaction, conviviality), suggests that sound level may have an influence that people don't consciously recognize. This is confirmed by our exploration of simple meditations of the influence of sound level on our four dependent variables by soundscape ratings. The direct effect of sound level on amount and time spent in the restaurant is conserved, with no mediation by the soundscape variables we tested. No full mediation path appears significant for the influence of sound level on satisfaction and conviviality.

However, these simple mediation analyses reveal that some of the soundscape variables have a significant or almost significant effect on time spent, satisfaction and conviviality. We, therefore, decided to explore further with conditional process analyses adding two moderators, participants' noise sensitivity score and the number of people at their table, to the mediation models tested above. Those analyses reveal no new information in the case of the amount spent in the restaurant and satisfaction, but we see a path of indirect influence of sound level on conviviality (despite the direct effect not being significant), and on time spent, through the monotonous rating and moderated by the number of people at the table. The number of people at the table moderates the effect of sound level on how monotonous diners rate the soundscape. That is, for tables of 3 or fewer diners, the higher the sound level, the less monotonous the soundscape; while for table with more than 3 diners, this effect is absent. This indicates that people seem to pay less attention to the soundscape as their group increases in size. And, as monotonous judgments decrease, time spent in the restaurant and conviviality ratings significantly increase. In the case of self-reports, this suggests that the perception of conviviality might offer a look into a richer cognitive process than satisfaction when exploring the experience of people in commercial interactive spaces. The number of people eating together seems to be a factor of increased conviviality through, not only the quality of company and conversation [36], but also through attentional processes. In comparison, satisfaction does not appear to be influenced by the sound environment as much.

5. Conclusion

While exploratory in nature, this is one of few studies to use the soundscape approach and administer the commonly-used SSQP scales in an indoor setting. Expectedly, measured sound level had an effect on the soundscape ratings. Soundscape judgments also appeared to have more influence than music ratings on the participants' approach behaviors (time and money spent) and overall judgments of their experience (satisfaction and conviviality). Additionally, to the best of our knowledge, this is the only study to look directly at the perceived conviviality of a restaurant setting. Conviviality showed potential for more complex associations with soundscapes judgments than satisfaction, and should be further investigated as a judgment of commercial experiences. Finally, we see in this study, that behaviors (time and money spent) could present a clearer picture of the outcomes of a commercial experience, compared to self-reported judgments of the experience (satisfaction and conviviality ratings).

5.1. Limitations and future directions

Our research presented various methodological limitations. First, restaurant staff understandably did not allow extreme variability across conditions and modulated the music level based on clients' wishes. Staff also required that the recording equipment be concealed, thus preventing the use of sound level meters in multiple locations. Future research will look into extending the investigation to additional locations in the restaurant. Second, this study was exploratory in nature, with the collaboration of a single commercial restaurant, thus limiting the generalizability of our results. Future steps will explore a wider range of restaurant type. Third, data collection relied primarily on self-report. The data may have shown some bias towards a better perception of the restaurant, as some participants were under the impression that the questionnaire was part of an in-house customer satisfaction survey despite being told otherwise by the experimenter. Finally, there was a potential selection bias regarding personality traits, as our participants scored above average on extraversion. Given the social connotation of this personality trait, it may be supposed that extraverted people might tend to go out more and to be more willing to participate in studies. The same might be said about noise sensitivity, as this restaurant seemed to have been selected by some participants for its relative calm. In spite of these limitations, this study has created the basis for further investigation of the relationships between restaurant soundscapes and consumer behavior.

6. Acknowledgments

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7. Conflict of interest

The authors declare that there is no conflict of interest.

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9. Ethical approval

Ethical approval for this project was given by the Research Ethics Board II of McGill University [REB #30-0615].

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Appendix A

A1 – Questionnaire contents in English

Section	Q #	Question	Scale/Response	Analyzed
These questions are about your experience in the restaurant today:				
Restaurant experience	1	Overall, I am satisfied with my experience	Strongly disagree 1 – 5 strongly agree	Y
	2	I find this restaurant's ambiance convivial	Strongly disagree 1 – 5 strongly agree	Y
	3	I find this restaurant:	Low-end 1 – 5 High-end	Y
"Soundscape is the word we are using to describe your sound/sonic environment as you perceive it. The soundscape includes *all* of the sounds around you."				
Soundscape judgments	4	I find the soundscape:		Y
		Pleasant	Strongly disagree 1 – 5 strongly agree	
		Unpleasant	Strongly disagree 1 – 5 strongly agree	
		Eventful	Strongly disagree 1 – 5 strongly agree	
		Vibrant	Strongly disagree 1 – 5 strongly agree	
		Monotonous	Strongly disagree 1 – 5 strongly agree	
		Calm	Strongly disagree 1 – 5 strongly agree	
		Chaotic	Strongly disagree 1 – 5 strongly agree	
	5	The soundscape I hear is appropriate for the atmosphere of the restaurant	Strongly disagree 1 – 5 strongly agree	Y
	6	Can you list some sounds that you hear here in the restaurant that are:		Y
		Pleasant	Free response	
		Unpleasant	Free response	
		Neutral	Free response	
	7	For the sounds you named above, can you circle the ones that you hear most prominently?	Free response	Y
	8	The sound level of the restaurant is:	Very low 1 – 5 Very high	Y
	9	I find the sound level:	Too low – Low – Appropriate – High – Too high	N
	10	I paid attention to the music during the meal	Not at all 1 – 5 A lot	N
	11	I find the music pleasant	Strongly disagree 1 – 5 strongly agree	Y
	12	The music I hear is appropriate for the atmosphere of the restaurant	Strongly disagree 1 – 5 strongly agree	N
The following questions are not about your experience in the restaurant today, but rather your general reactions in everyday life:				

Person-related and situational factors	13	For the following items, please circle the musical genre(s) you enjoy listening to:		N
		Classical	Y/N	
		Blues	Y/N	
		Country	Y/N	
		Dance/Electronica	Y/N	
		Folk	Y/N	
		Rap/Hip-hop	Y/N	
		Soul/Funk	Y/N	
		Religious	Y/N	
		Alternative	Y/N	
		Jazz	Y/N	
		Rock	Y/N	
		Pop	Y/N	
		Heavy metal	Y/N	
		Soundtracks/Theme songs	Y/N	
	14	I am sensitive to noise	Strongly disagree 1 – 5 strongly agree	Y
	15	I find it hard to relax in a place that's noisy	Strongly disagree 1 – 5 strongly agree	
	16	I get mad at people who make noise that keeps me from falling asleep or getting work done	Strongly disagree 1 – 5 strongly agree	
	17	I get annoyed when my neighbors are noisy	Strongly disagree 1 – 5 strongly agree	
	18	I get used to most noises without much difficulty (reverse scored)	Strongly disagree 1 – 5 strongly agree	
	19	I see myself as Extraverted, enthusiastic (that is, sociable, assertive, talkative, active, NOT reserved, or shy)	Strongly disagree 1 – 5 strongly agree	Y
	20	On average, in a typical year, how often do you dine outside of your home in a commercial establishment?	Daily – A few times a month – Once a year or less – A few times a week – A few times a year	N
	21	How many people are eating at this table today? (yourself included)	Free response	Y
	22	Who are you eating with?	Friends – Family members – Colleagues – Clients – With your partner – On your own	N
	23	Year of birth	Free response	Y
	24	Sex	F/M	Y
	25	Do you live in Montreal?	Y/N	Y
		Since when?	Free response	
	26	If not, where do you live?	Free response	N
	27	Do you have any comment?	Free response	Y

A2 – Questionnaire contents in French

Section	Q #	Question	Scale/Response	Analyzed
Ces questions portent sur votre expérience dans ce restaurant aujourd'hui :				
Restaurant experience	1	Dans l'ensemble, je suis satisfait(e) de mon expérience	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	2	Je trouve l'ambiance de ce restaurant conviviale	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	3	Je trouve que ce restaurant est :	Entrée de gamme 1 – 5 Haut de gamme	Y
"L'ambiance sonore décrit votre environnement sonore tel que vous le percevez. Il inclut tous les sons et bruits autour de vous."				
Soundscape judgments	4	Je trouve l'ambiance sonore :		Y
		Agréable	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Désagréable	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Animée	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Dynamique	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Monotone	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Calme	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
		Chaotique	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
	5	L'ambiance sonore est appropriée pour l'atmosphère du restaurant	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	6	Dans cette ambiance sonore, que percevez-vous comme étant :		Y
		Agréable	Free response	
		Désagréable	Free response	
		Neutre	Free response	
	7	Dans la liste ci-dessus, pouvez-vous entourer ce(ux) qui est (sont) plus important(s) pour vous ?	Free response	Y
	8	Le volume sonore du restaurant est :	Très faible 1 – 5 Très fort	Y
	9	Je trouve le volume sonore :	Beaucoup trop faible – Trop faible – Approprié – Trop fort – Beaucoup trop fort	N
	10	J'ai fait attention à la musique pendant mon repas	Not at all 1 – 5 A lot	N
	11	Je trouve la musique agréable	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	12	La musique est appropriée pour l'atmosphère du restaurant	Pas du tout d'accord 1 – 5 Tout à fait d'accord	N
Les questions suivantes ne concernent pas votre expérience au restaurant aujourd'hui, mais vos réactions <u>en général au quotidien</u> :				

Person-related and situational factors	13	Pour les items suivants, veuillez entourer les genres que vous appréciez écouter dans la liste ci-dessous :		N
		Musique classique	Y/N	
		Blues	Y/N	
		Country	Y/N	
		Dance/Musique électronique	Y/N	
		Folk	Y/N	
		Rap/Hip-hop	Y/N	
		Soul/Funk	Y/N	
		Musique religieuse	Y/N	
		Musique alternative	Y/N	
		Jazz	Y/N	
		Rock	Y/N	
		Pop	Y/N	
		Heavy metal	Y/N	
		Musique de films/séries	Y/N	
	14	Je suis sensible au bruit	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	15	Je trouve difficile de me relaxer dans un endroit bruyant	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
	16	Je me mets en colère contre les personnes qui font du bruit qui m'empêche de m'endormir ou de travailler	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
	17	Je m'énerve quand mes voisins sont bruyants	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
	18	Je m'habitue à la plupart des bruits sans difficulté (reverse scored)	Pas du tout d'accord 1 – 5 Tout à fait d'accord	
	19	Je me considère extraverti(e), enthousiaste (c'est-à-dire sociable, affirmé, loquace, actif, et NON réservé(e) ou timide)	Pas du tout d'accord 1 – 5 Tout à fait d'accord	Y
	20	En moyenne, dans la dernière année, à quelle fréquence avez-vous mangé hors de chez vous dans un établissement commercial ?	Tous les jours – Quelques fois par mois – Une fois par an ou moins – Quelques fois par semaine – Quelques fois par an	N
	21	Combien de personnes sont à table avec vous aujourd'hui ? (y compris vous)	Free response	Y
	22	Avec qui êtes-vous venus manger ?	Ami(e)s – Famille – Collègues – Clients – En couple – Seul(e)	N
	23	Quelle est votre année de naissance :	Free response	Y
	24	Vous êtes :	Un homme / Une femme	Y
	25	Vivez-vous à Montréal ?	Y/N	Y
		Si oui, depuis combien de temps ?	Free response	
	26	Si non, où vivez-vous ?	Free response	N
	27	Avez-vous des commentaires ?	Free response	Y

Appendix B

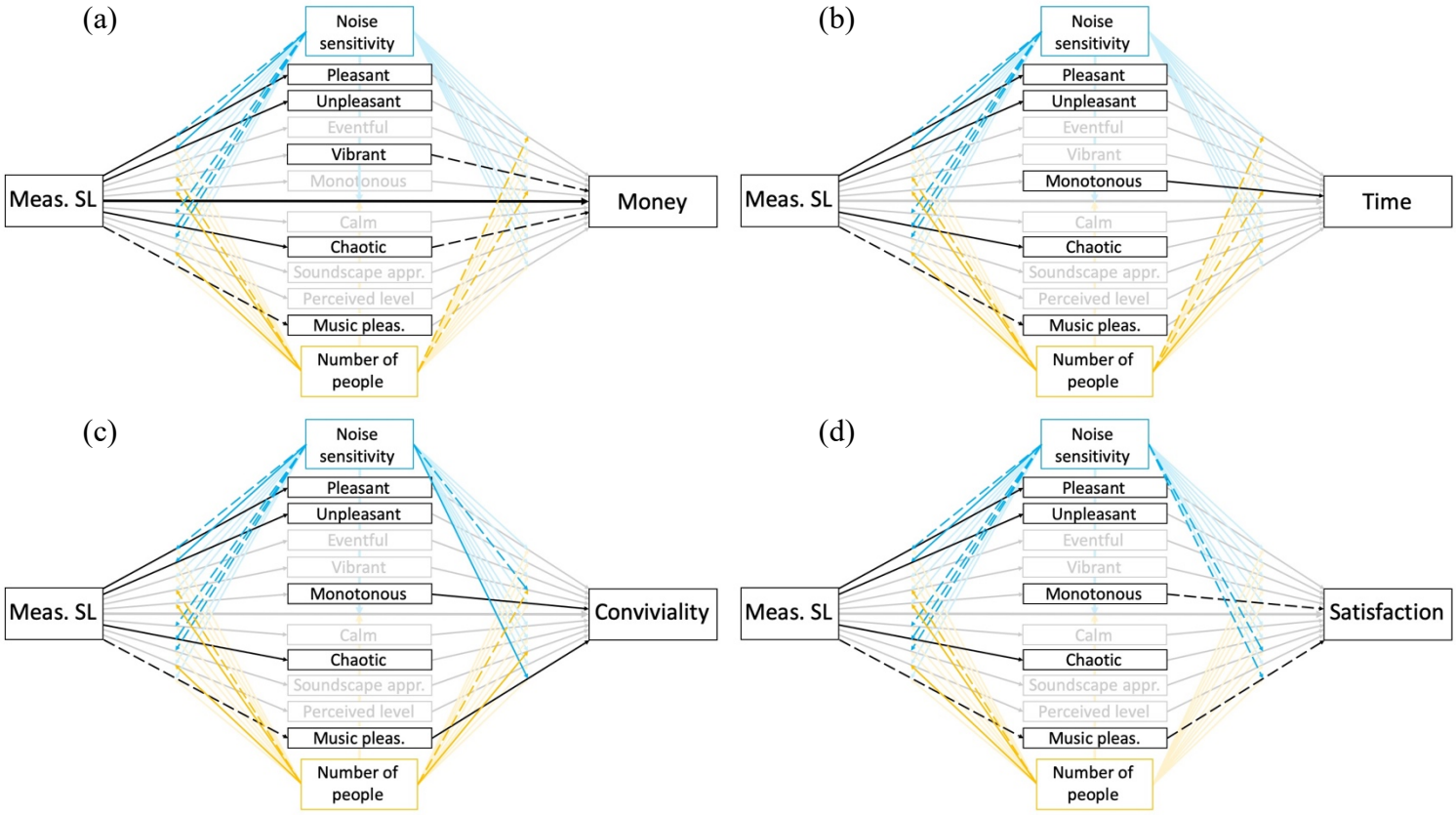

Figure 9. Conditional process analysis models of the influence of measured sound level (Meas. SL) on money (a) and time (b) spent in the restaurant, and conviviality (c) and satisfaction (d). Arrows show significant ($p < .05$ – solid lines), near-significant ($p < .1$ – dashed lines), and non-significant ($p > .1$ – greyed out lines and labels) relationships. Mediators are shown in black and moderators in blue (participant noise sensitivity) and yellow (number of people at the table).