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Sensory characteristics of a place: The development of the sensory walk questionnaire

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ABSTRACT

Surrounding plays an important role in well-being and affects behaviour. The experience of the environment is multi-sensory, we perceive different visual, auditory, olfactory, and somatosensory cues, but until today, there has not been a method to measure and characterize the sensory experience of a place systematically. The current paper aims to 1) develop the Sensory Walk Questionnaire, and 2) test the questionnaire in a restaurant environment. The Sensory Walk Questionnaire was developed by reviewing literature and interviewing architectural experts. 318 respondents completed the Sensory Walk Questionnaire in Flavoria(R) Research Restaurant. The study showed that the three test areas in the restaurant; the lobby, the dining area and the waste point differed ($p < 0.05$) in the perceived odour and sound intensity, in the pleasantness of odours, sounds and visual environment, as well as several sensory descriptors used to characterize these locations. The Sensory Walk Questionnaire provides a valuable tool to measure the sensory quality of places.

1. Introduction

When arriving in a new place, people make many sensory observations about the surrounding environment. Whether the surrounding is experienced as pleasant or unpleasant can have a major effect on our behaviour in the place. Donovan, Rossiter, Marcoolyn, & Nesdale (1994) showed that retail store environments that consumers find more pleasant increased the time spent in the store as well as money spent in the store. The sensory characteristics of a place affect e.g., how we perceive and value the indoor spaces (Ceylan, 2020; Haghbayan, Malek, & Tashayo, 2020; Imschloss & Kuehnl, 2017; Kim & Kim, 2020; Ocepek, 2018), how we choose and/or experience e.g. food products in the place (Kontukoski et al., 2015; Kontukoski, Paakki, Thureson, Uimonen, & Hopia, 2016; Spence & Carvalho, 2020), and they also can reduce stress, enhance well-being and increase work productivity (Clements-Croome, Turner, & Pallaris, 2019; English, Wilson, & Keller-Olaman, 2008; Pálsdóttir, Spendrup, Mårtensson, & Wendin, 2021; Sona, Dietl, & Steidle, 2019; Souter-Brown, Hinckson, & Duncan, 2021). Sensory experiences have been recognized as central to the design of urban built environments (M. M. Degen & Rose, 2012). Helmefalk (2016) concludes that for a retail setting to be pleasant for consumers, firms should consider and utilize individual sensory cues concerning the holistic perspective of their products, services, and store image. Overall, multisensory stimuli should be considered an essential aspect of the design and planning framework of public spaces to create a pleasant and healthy environment (Clements-Croome et al., 2019; Henshaw, 2014; Mathiesen, Hopia, Ojansivu, Byrne, & Wang, 2022; Xiao & Aletta, 2016; Xiao et al., 2021).

The role of each sense in a spatial experience has been identified. *Visual elements* of a place can include everything from the interior design such as brightness of the lightning, colours, size and shape of the space, openness, layout, greenery, visual connection to nature, floor patterns, ceiling décor, price displays, signs, and point of purchase displays (Colenberg, Jylhä, & Arkesteijn, 2021; Helmefalk, 2016; Ko et al., 2020; Wastiels, Schifferstein, Heylighen, & Wouters, 2012; Yu, 2009). In a review article, (Spence, Puccinelli, Grewal, & Roggeveen, 2014) concluded that a more visually appealing environment encourages shoppers to stay longer, and possibly purchase more. However, they recognize that specifying an appropriate visual design solution for any given store environment is more challenging. An example of the effect of different visual cues on product experience is shown in a study by (Motoki, Takahashi, & Spence, 2021), where they showed that more reddish and lighter-coloured coffee shops were associated with the expectations that the coffee served would be sweeter, while greenish and

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darker coloured coffee were associated with more sour/bitter/tastier coffee.

A*uditory cues* in a place include music, noise, natural sounds, and other background sounds, which have been shown to influence purchase intentions, (Bravo-Moncayo, Reinoso-Carvalho, & Velasco, 2020), behaviour, e.g., eating rate (Mathiesen et al., 2022), and the choice and experience of products (Kontukoski et al., 2015; Woods et al., 2011). Noise in places refers to negative sounds, which can arise e.g., from road traffic and can cause annoyance and even health issues (Radicchi, Henckel, & Memmel, 2018). Radicchi et al., (2018) found that natural and human-related sounds, coming from birds, human voices, wind, and water were evaluated as positive sounds in the city, whereas traffic and ventilation were experienced as negative by naive respondents. Mathiesen et al. (2022) showed that the appropriateness and liking of the sonic atmosphere positively correlated with the overall pleasantness of the eating experience in a restaurant. Research has distinguished physical properties (volume, pitch, tempo), emotional tone (positive, negative), and liking of elements determining the influence of music and sound (Spence et al., 2014). An optimal auditory atmosphere seems to appear when an optimal level and type of stimulation are combined in a place.

Olfactory cues i.e., scents can affect consumers consciously or unconsciously. Smells are inevitable in people's everyday experiences in cities, variously sourced from human activities to building materials and landscapes, forming an invisible world around us (Xiao, Tait, & Kang, 2018). In the situation, where there is an intention to influence response, the scents are either revealed openly or the use of scent is imperceptible to recipients (Henshaw, Medway, Warnaby, & Perkins, 2015). The smell can provide a more overtly immersive experience for the consumer of service environments (such as retail stores and hotel lobbies) (Henshaw et al., 2015). Olfactory cues may have a great impact through associative means and more so than other sensory cues, a customer's response to olfactory cues is more likely to be hedonically charged (i.e., either positive or negative) (Spence et al., 2014). Nature-related smells have been connected to positive emotions as well as stress reduction (Pálsdóttir et al., 2021), food odours can have both positive and negative connotations, and they may be recalled clearly after many years in the past (Degen & Rose, 2012).

Somatosensory cues can be described for example in terms of the sensory-discriminative qualities of softness, smoothness, and temperature (Kotler, 1973). Skin is the central sensory organ of touch. Using touch, we can immediately and easily discriminate great varieties of objects. The sense of touch collects information through mechanical, thermal, and chemical signals (Biswas & Visell, 2021). The main somatosensory descriptors are smooth-rough, weight, thermal, and compliance (Dacremont & Soufflet, 2006; Lederman & Klatzky, 2009). Imschloss & Kuehnl (2017) showed that haptic-kinesthetic sensations of soft vs. hard flooring affect product evaluation in a retail environment.

Taste sensations of a place are less studied or have not been considered as important as atmospheric factors (Kotler, 1973). Taste sensations are described as important in making grocery shopping decisions, but the sensations are related to either free samples or previous experiences with the products, not the environment itself (Ocepek, 2018). A sense of taste in a place will be excluded from this paper.

Even if humans perceive and experience the surrounding environment through several senses, multi-sensory evaluation of the environment has been a minority in scientific literature. An interest in sensory experiences of places has grown in research and design, but mostly the research has focused on a single sense channel at a time, and sight has been the most dominant one (Aletta et al., 2019; Bruce, Condie, Henshaw, & Payne, 2015; Kim & Kim, 2020). Degen & Rose (2012), Henshaw et al. (2015) and Low (2015) argued that other senses than sight have been largely ignored in academic discussions of place research.

As research methods, Smellwalk and smellscape are exploratory concepts that have been used in measuring and describing the sensory experience of environmental odours. The smellwalk study protocol has been developed to involve naive study participants in situ study locations (Low, 2015; Xiao et al., 2018). Measuring smells has been used in planning rural environments (Bruce et al., 2015; Caffyn, 2021), as a design approach for the built environment (Balez, 2002), as well as a therapeutic (English et al., 2008; Pálsdóttir et al., 2021) or experiential element for tourism and well-being, or as an element of historical and cultural value (Castro & Burdick, 2020; Xiao et al., 2021). Understanding and measuring the perceptual quality of smellscapes is needed to guide the future design of smell environments (Xiao et al., 2018, 2020). Smellscapes can be also managed and controlled via different methods, namely, separation, deodorization, masking, and scenting (Henshaw et al., 2015). In either case, the management requires smell identification and an understanding of multi-sensory perception.

Accordingly, a soundwalk is a procedure, where the researcher walks along with the participants into the target place to listen and describe their experiences of environmental sounds for research purposes. Soundscape has been defined as 'the acoustic environment perceived or experienced by a person or people in a place (influenced by its context) (Aletta et al., 2019; ISO 12913-1: 2014). Soundwalks have been specifically used to profile the soundscape of various cities (Atkinson, 2007; Botteldooren et al., 2006; Aiello, Schifanella, Quercia, & Aletta, 2016a; Bruce et al., 2015; Kang, Aletta, Margaritis, & Yang, 2018; Liu, Kang, Luo, & Behm, 2013; Radicchi et al., 2018; Porteous and Mastin, 1985).

Somatosensory measurements have mainly focused on mechanoreceptors and thermoreceptors located within the hairless skin of the human hand (Lederman & Klatzky, 2009). Typically, in studies concentrating on haptic perception only, the participants are blindfolded to prevent them from using visual information (Kahrimanovic, Tiest, & Kappers, 2010). In the recent past, the number of assessments of thermal perception of outdoor urban spaces has increased (Henshaw & Guy, 2015; Klok, Rood, & Kleerekoper, 2019; Liu, Nazarian, Niu, Hart, & de Dear, 2020) due to needing to address urban heat problems because of rising temperatures. Studies on thermal perception can show the benefits of designing natural or artificial shades in urban environments, as they can provide substantial cooling and thermal comfort in urban spaces (Klok, Rood, & Kleerekoper, 2019).

The research in urban and architectural studies has taken mainly a qualitative approach to understanding sensory experiences, and quantitative methods are a minority. E.g., smell and sound environment description data have been traditionally collected in qualitative recordings, interviews, and focus groups (Aletta et al., 2019; Pálsdóttir et al., 2021; Quercia, Schifanella, Aiello, & McLean, 2015), which gives rich information but makes the comparison of different places challenging.

Research would benefit from easy and standardized tools to measure and map the human multi-sensory experience of places (Aletta et al., 2019; Henshaw & Guy, 2015). Mapping of sensory experiences can be used as the first step to localize and recognize the potential problems in an environment and point out the characteristics that should be developed to enhance the experience of an environment.

This paper suggests a holistic and quantitative tool 'A Sensory Walk Questionnaire' to measure the human experience of a place. One main part of the tool is a constructed lexicon for the characterization of sound, smell, visual, and somatosensory elements using a CATA question, to measure the consumer experience in a place. The developed questionnaire also includes the measurement of hedonic liking as well as the evaluation of the intensity and appropriateness of the sensations in a place. The possibilities of the tool for environment development are discussed.

This paper has two objectives:

- To develop a Sensory Walk questionnaire, which characterizes the surrounding experience using a constructed multi-sensory lexicon and includes other measures seen as valid in the context. The lexicon is constructed first, by a review of the literature used in describing an environment, area, or place through different senses (sound, smell,

vision, and touch). And secondly, expert discussions with architects and landscape architects to ensure the comprehensiveness and usability of the lexicon while developing different locations.
- To test the Sensory Walk Questionnaire in a case study. A case study is conducted in a restaurant environment in three different locations to measure the lunch restaurant environment using four senses.

2. Materials and methods

2.1. Development of the lexicon

2.1.1. Literature review search strategy

A literature review was conducted to construct a multi-sensory lexicon to characterize a surrounding. An online literature search was performed using Scopus and JSTOR databases for scientific peer-reviewed literature, which were screened for relevant publications including research and review articles, to comprise a significant amount of literature data. Both databases include high-quality and peer-reviewed journal articles. This step included the identification and selection of suitable sources for the literature review. The search was performed on predetermined combinations of keywords along with Boolean operators ("AND", "OR") and had no temporal restrictions. Keywords such as location and place were combined separately for each of the senses to capture relevant publications on this topic. After the search, the screening of relevant articles took place. After reading the title and/or abstract it was decided whether a study might be relevant to the lexicon. Articles that did not contain descriptions of human sensory experience or describing characteristics were excluded because the purpose of the review was to understand perception in different situations and construct the lexicon. The purpose was not to execute an extensive review of the whole topic of sensory perception in a place but to gather terms used to describe the perception in different environments and cultures. The search terms that were applied in this study to find the literature and the main articles used to generate the lexicon can be viewed in Supplementary material A.

The main categories of reviewed literature included psychology, engineering, agricultural and environmental design, social sciences, and archaeology in a few subject areas.

The literature review generated a total of 730 individual terms to describe smells, sounds, sights, or somatosensory elements of an environment. Of these attributes, 270 were related to smells, 236 were related to sounds, 88 were sight attributes and 136 characteristics were related to somatosensory sensations (Supplementary material B).

The largest source for smell-related words was from urban smell dictionary projects (Quercia et al., 2016, 2015). See also: https://goodcitylife.org/. They coded previous smellwalk literature, handwritten notes from several smellwalks conducted across cities of the UK, EU, and USA, and social media data. Aiello et al. (2016a), Aiello et al. (2016b) conducted a large taxonomy project to search and classify urban sound-related words from the World Soundscape Project as well as from online crowdsourced sources. They compiled two sets of sound-related words into the first urban sound dictionary. Haghbayan et al. (2020) used a crowdsourcing approach to collect visual descriptors of indoor spaces. The somatosensory lexicon was constructed based on studies related to thermal sensation (Klok et al., 2019; Liu et al., 2020; Saeidi et al., 2021), and descriptors used to describe e.g. different textiles (Dacremont & Soufflet, 2006), or flooring (Imschloss & Kuehnl, 2017).

2.1.2. Expert interviews

After the literature search, semi-structured interviews were conducted with three environmental design experts with a degree in architecture or landscape architecture and several years of experience to assess the coverage of the lexicon. The semi-structured nature of the interviews allowed the professionals to express different perceptions and views based on their experience and knowledge.

Interviews were conducted individually either face-to-face or via video call by the same researcher. During the interviews, each sense channel was discussed separately, first starting with an open-ended question e.g., for odours "*Please, based on your own experiences and architectural design, describe the different odours that can be associated with surroundings of a space/place?*". The descriptors the experts described were all recorded. After the expert was satisfied with the descriptors listed for odours, the constructed vocabulary for odours based on a literature search was viewed. The expert was asked to "*Familiarize yourself with the lexicon and choose the characteristics that you could use to describe the experience in a space/area*". The same steps for the open-ended question and reviewing the vocabulary list were repeated for each of the senses. The interviews lasted on average 55 min. Content analysis was conducted via open coding by collecting the descriptors mentioned by the experts and analysing the terms seen as potential.

When two of the three experts mentioned a new characteristic to the lexicon it was considered important. These kinds of terms were concrete, tar and timber for odours, echo, and announcements for sounds, and hilly, closed, stagnant and in movements for visuals. These additions show that partially the characteristics might be culture-specific or local because for example tar and timber are not probably potential terms to all countries but can be experienced in the Finnish environment.

2.2. Preparing the lexicon for the Sensory Walk Questionnaire

Architectural design research has called for researchers from different disciplines to study the sensory experiences in a place (Xiao et al., 2021), and sensory evaluation of food could offer good practices for this. Descriptive sensory analyses allow the characterization of complete sensory descriptions of products in terms of appearance, odour, taste, flavour, and texture (Lawless & Heymann, 1998). As a result, the sensory profile gives a quantified description of the sensory characteristics of the target. A Check-all-that-apply (CATA) is a well-defined consumer-based method that can be used to measure which of the attributes describes the product the most (Varela & Ares, 2012). Here, CATA questions were chosen as the question type that allows consumers to easily characterise the quality of a place through their senses. The terms included in the CATA question were divided per sensory modality (primary category) and instead of a long list, a few shorter list blocks were used (secondary categories). This has been found to encourage consumers to use more terms to describe the target and consumers were expected to find it easier to view the shorter lists of descriptors (Ares et al., 2013).

Heavy term categorizing and merging of similar terms but maintaining a generalizable CATA lexicon resulted in a total list of 136 sensory terms (Table 1). The lexicon for odours and sounds includes six secondary categories: nature, people, traffic, and modality-specific categories; food, garbage, and others to odours (similar to Balez, 2002; De Coensel, Botteldooren, Debacq, Nilsson, & Berglund, 2008; Quercia et al., 2015) and indoor, mechanical, and music to sounds (Aiello et al., 2016a; Aletta et al., 2019; Liu et al., 2013; Oberman, Jambrosic, Horvat, & Scitaroci, 2020). For visual terms, three secondary categories were chosen: lighting, angle, and detailing, and for somatosensory vocabulary three as well: temperature, humidity, and tactile (S. Liu et al., 2020). The secondary categories were decided based on both literature and interviews with the architects. The number of sensory terms included in each CATA block was kept short (12–16 terms or less) (Ares, Antúnez, Giménez, & Jaeger, 2015).

2.3. Sensory Walk Questionnaire

The Sensory Walk Questionnaire (Table 2) was built to measure and characterize the holistic multi-sensory experience of a place. The Sensory Walk Questionnaire begins with an assessment of the intensity of the sensations (smells and sounds only, as the intensity of visual and somatosensory sensations was considered difficult to evaluate), the

Table 1
The Sensory walk lexicon.

Odours	Nature	People	Food
	flowers & plants	sweat	coffee
	trees	flatulence	spices/herbs
	fresh air	perfume	fresh bread
	sea	aftershave	fruity
	grass		barbeque
	soil		fast food
	stone		general food
	forest		pastrysmoked
	sand		
	concrete		
	Traffic&Industry	Garbage	Other
	exhaust	trash can	tobacco
	gasoline	toilet/urinedirt	air freshener
	street dust		room scentcardboard
	pollutant		leather
	industry		plastic
			detergent
			timber
			chemical
			tarsynthetic
			metal
Sounds	Nature	People	Indoor
	bird sing	conversationwhispering	air conditioning
	dog's barkinghum of the trees	laughter	computer
	wind	human noise	paper rustle
	rustle of the leaves	children	flushing the toilet
	rain	walking steps	echoannouncements
	sea	running stepsclattering footsteps	cutlery sounds
	water flowfountain		
	wavessilence		
	Traffic	Mechanical	Music
	traffic	drilling	radiobackground music
	motorbike	ringing	fast music
	trainsirens	clatter	slow music
	airplane	clock tickingbeeping	
	tramhum of the city	video game	
Visuals	Lighting	Angle	Detailing
	dark	flat	detailed
	dim	hilly	decorative
	bright	intimate	empty
	natural lightningartificial lightning	small	clear
	lyricalsurprising	large	uniform
		spaciousopen	confused
		closed	chaotic
		green	intriguing
		colorful	
		monochrome	
		stagnantin movement	
		untidy	
		tidy	
Somatosensory	Temperature	Humidity	Tactile
	freezing/cold	dry	light
	cool	humid	heavy
	warm	wet	smooth
	hot		rough
	windy/airy		uneven
	standing air		soft
	body warm		angular
			slippery
			hard
			velvety

pleasantness evaluation of the sensation, choosing the descriptive characteristics from the vocabulary, and evaluating the appropriateness of the sensation to the place. Finally, the overall liking, and wellness in the place are evaluated. Assessing the intensity, pleasantness, and appropriateness of smells (Henshaw et al., 2015; Xiao et al., 2018), sound environments (Aiello et al., 2016a; Aletta et al., 2019), and thermal experiences (Liu et al., 2020) has been considered essential in previous studies. Wellness evaluation was adapted from The WellSense Profile™ (King et al., 2015) by selecting the attributes suitable for a place experience. The original questionnaire in Finnish is provided as Supplementary material C.

In the case study, the consumers were able to add free descriptions of sensations after each CATA question. This was added to analyse the possible missing descriptors from the lexicon in the case study context. In addition, the consumers were able to report the most intensive or priority sensation after evaluating each sense in their own words. This was used to evaluate the content of the lexicon.

2.4. Case study in lunch restaurant

2.4.1. Participants

A total of 318 participants between 20 and 66 years old (Mean of age

Table 2
The Sensory Walk Questionnaire.

Measure	Question phrasing	Scale structure
1. Odour intensity	Please, inhale and exhale slowly a couple of times. How strongly do you perceive the smells surrounding you?	an unlabelled 7 point-scale 1: Not at all; 7: Very intense
2. Odour liking	What do you think of the surrounding smells?	a labelled 7 point-scale (scale ends anchored 1: Very unpleasant; 7: Very pleasant).
3. Odour characteristics	Check all the characteristics you experience at the moment?	43 sensory terms under six categories. Something else, what? was an option to add respondents' free descriptions
4. Odour appropriateness	How appropriate the smell experience is for this place?"	a labelled 5-point scale (1: Not at all appropriate, 2: Slightly appropriate, 3: Quite appropriate, 4: Very appropriate, 5: Fully appropriate).
5. Sound intensity	Please, focus on the sounds surrounding you. How strongly do you perceive the sounds surrounding you?	7 point-scale
6. Sound liking	What do you think of the surrounding sounds?"	7 point-scale
7. Sound characteristics	Check all the characteristics you experience at the moment?	43 CATA terms for sounds under six categories with a free comment possibility.
8. Sound appropriateness	How appropriate the sound experience is for this place?	5 point-scale
9. Visual liking	Please, focus your attention on the surroundings by looking. What do you think of the view in the surroundings?"	7 point-scale
10. Visual characteristics	Check all the characteristics you experience at the moment?	28 CATA terms for visuals under three categories with a free comment possibility.
11. Visual appropriateness	How appropriate is the surrounding view for this place?	5 point-scale
12. Liking of somatosensory sensation	Please, focus on the whole-body sensations in this environment. What do you think of the environment in terms of whole-body sensations?	7 point-scale
13. Somatosensory characteristics	Check all the characteristics you experience at the moment?	20 CATA terms for somatosensory sensations under three categories with a free comment possibility.
14. Appropriateness of somatosensory	How appropriate are the sensations you experience throughout your body fit for this particular place?	5 point-scale
15. Overall liking	Evaluate the whole experience (smells, sounds, view and feel) together. What do you think of the environment?	7 point-scale
16. Evaluation of wellness	Which of the following terms describes how you feel in this environment?	21 selected terms from the WellSense Profile™

32 years old, SD 10.5) joined the study (29 % males, 70 % females, and 1 % did not want to specify). Participant characteristics are reported in Table 3, which reflects the overall customer profile of the restaurant. The study was conducted in the Flavoria® restaurant, which is a Sodexo-operated restaurant at the university and hospital campus area with around 1,000 daily customers. The naive participants were recruited in situ from three different study areas in a lunch restaurant among restaurant clients (Fig. 1), one respondent was allowed to participate

Table 3
Participant characteristics in three different study areas. Frequencies of gender in percentages and age as means ± SD.

Study area	Lobby entering the restaurant	Dining area	Waste point
n	103	109	106
Women/Men/Other	73/26/1	68/31/1	70/28/2
Age	32.3 ± 10.7	32.2 ± 9.8	31.6 ± 11.1

only once and only in one study area. In the lobby, the subjects were recruited among the people queuing for the restaurant. Recruitment at the dining area was done after the subjects had finished eating their lunch but were still sitting at the dining area, and at the waste point after subjects had left their cutlery and the tray to wash.

2.4.2. Procedure

The study protocol was approved by the Ethics Committee for Human Sciences at the University of Turku, Humanities and Social Sciences Division (37/2021). The study follows the European Union's General Data Protection Regulation (GDPR). Written consent was obtained for the study before participation. Participants gave informed consent via the statement "I am aware that my responses are confidential, and I agree to participate in this survey" where an affirmative reply was required to enter the survey. They were able to withdraw from the survey at any time without giving a reason.

Data collection took place on Wednesday to Friday during normal lunch hours between 10:30–13:00 in February 2022. The subjects were informed about the aim to collect sensory experience of the location they currently were. As an incentive to join the participants received a snack (a chocolate bar or fruit) as a reward.

The subjects were able to enter the study questionnaire using their own mobile phone or using iPad provided by the recruiters. The data were collected using Compusense20 (Version 22.0.11, Compusense Inc, Guelph, Ontario, Canada).

2.4.3. Data analysis

A between-participant design was used, where ratings of sensory and hedonic experiences were used as the main dependent variables. Sensory intensity, liking, and appropriateness scores were analysed using analysis of variance (ANOVA) considering the study area as a fixed source of variation and consumer as a random effect. Tukey's test was used for post hoc comparison of average values.

The frequency of use of each sensory and wellness term was determined by counting the number of consumers that used the term to describe each study area. Chi-Square test was carried out to identify significant differences between study areas for each term included in the CATA questions.

All analyses were performed using IBM SPSS Statistics using $\alpha = 0.05$.

3. Results

3.1. Sensory Walk study in the restaurant

3.1.1. Intensities and liking of different sensory modalities

Odour and sound intensities were evaluated across the three locations. As shown in Table 4, odours were perceived as significantly more intense in the lobby and in the dining area, compared to the waste point ($p < 0.01$). The sound intensity was highest at the waste point (intensity 5.2 on a 7-point scale), significantly lower in the dining area, and significantly lower in the lobby.

Significant differences ($p \leq 0.05$) in the odour, sound, visual, and overall hedonic liking scores between the study areas were also found. The lobby area and the dining area were found more pleasant in odour, sound, visual and overall compared to the waste point. There were no

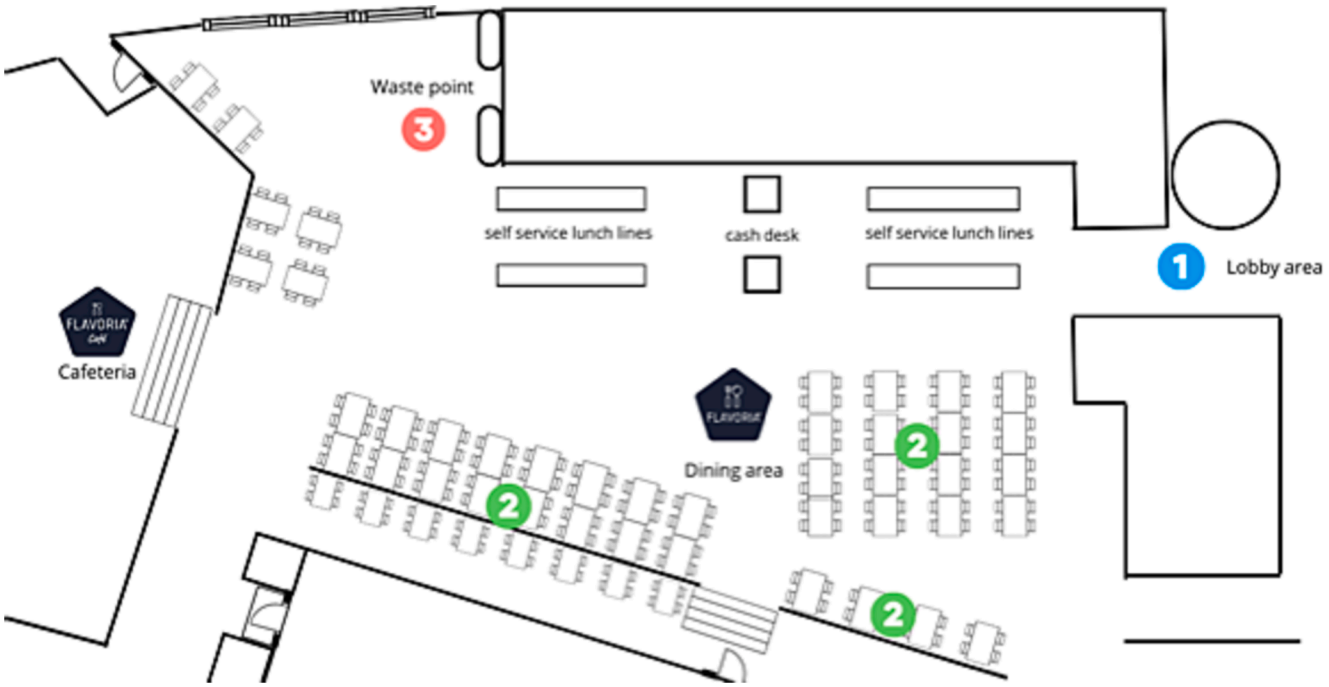

Fig. 1. Consumers participated in the study in three different areas: Lobby area (1), Dining area (2), and Waste point (3).

Table 4
F and p-values, mean liking scores, and SD for the restaurant areas evaluated. Intensities and pleasantness were evaluated on a 7-point scale.

Response variable	F	p	Lobby entering the restaurant	Dining area	Waste point
Odour intensity	5.16	0.006	$3.5^{a} \pm 1.5$	$3.4^{a} \pm 1.5$	$2.9^{b} \pm 1.4$
Sound intensity	16.57	<0.001	$4.4^{a} \pm 0.9$	$4.8^{b} \pm 1.0$	$5.2^{c} \pm 0.9$
Odour pleasantness	6.59	0.002	$5.1^{a} \pm 1.0$	$5.0^{a} \pm 1.1$	$4.6^{b} \pm 1.1$
Sound pleasantness	18.39	<0.001	$4.1^{a} \pm 1.1$	$4.1^{a} \pm 1.2$	$3.3^{b} \pm 1.0$
Visual pleasantness	7.64	<0.001	$5.4^{a} \pm 0.9$	$5.0^{b} \pm 1.1$	$4.8^{b} \pm 1.3$
Somatosensory pleasantness	1.09	0.338	4.8 ± 1.1	4.6 ± 1.2	4.6 ± 1.0
Overall pleasantness	3.93	0.021	$5.1^{a} \pm 1.1$	$4.9^{ab} \pm 1.1$	$4.6^{b} \pm 1.3$

significant differences between the areas in somatosensory pleasantness.

When comparing pleasantness between different sensory modalities, sound pleasantness was rated the lowest in liking, and the difference was significant ($p < 0.001$) between sound pleasantness and other sensory modalities in each test area.

3.1.2. CATA sensory characteristics

At the aggregate level, the odour terms 'general food' (73 %) and 'fresh air' (28 %) showed the highest frequency of use when participants were asked to describe the odour characteristics of the study areas. The most frequently used sound characteristics were 'speech/discussion' (85 %), 'human noise' (82 %), 'clatter (56 %), and walking steps (50 %), whereas the most frequent visual characteristics, were described as 'bright' (73 %), 'artificial light' (66 %), 'spacious' (61 %), and 'clear' (55 %). From the somatosensory characteristics, the most used terms were 'dry' (62 %), 'cool' (48 %), and 'windy/airy' (31 %).

Significant differences in the CATA characteristics were found in 16 terms out of a total of 136 between the three study areas. Seven of the discriminating terms were sound characteristics, six were odour characteristics, three were sight-related, and no differences in somatosensory characteristics. Spices/herbs were detected more often in the lobby and the dining area than in the waste point, where garbage cans and coffee odours were characterised more. To highlight area-discriminating characteristics in sounds, walking steps and clattering footsteps were detected more in the lobby than in other areas, the sound of laughter in the dining area, whereas water flow, echo, and clatter sounds were detected at the waste point. The waste point is positioned next to a large window, which produces more natural light in the area compared to other areas.

The characteristics showing differences between the study areas or having a frequency of over 15 % in a location are listed in Table 5.

Consumers were able to add free comments right after the CATA question blocks of each sensory modality. Few descriptors were detected that were not included in the lexicon. Comments added for the odour were: the face mask ($n = 11$ divided across all research areas), hand sanitiser ($n = 1$ in the lobby), and butter ($n = 1$ in the dining area). For the sounds, the added descriptions were the clinking of plates and glasses ($n = 16$ divided across all research areas), the sound from moving chairs ($n = 4$ in the dining area), the slamming of doors ($n = 2$), humming ($n = 2$), and the jingle of keys ($n = 2$). Clear colours ($n = 1$), and relaxing colours ($n = 1$) were added for the sight sense, as well as variable lightning ($n = 1$), inhospitable ($n = 1$), and ugly floor ($n = 1$). There weren't any additional words for the somatosensory sensations.

3.1.3. Appropriateness of the sensations

There were no statistically significant differences between the research areas in the appropriateness of the sensory stimuli (Table 6). However, the appropriateness between different sensory modalities differed. In the lobby, both odours and sight sensations were evaluated as more appropriate in the place than sound and somatosensory sensations ($p < 0.01$). In comparison, in the dining area, the odours were found to be more appropriate than sounds, visual and somatosensory sensations ($p < 0.01$). Odours and visual sensations were more appropriate than sounds and somatosensory at the waste point as well ($p < 0.05$).

Table 5
Contingency table as percentages for the CATA characteristics and p values from statistical testing for differences between the restaurant areas.

Term	p Value (Chi-Square)	Lobby entering the restaurant	Dining area	Waste point
Odour-Nature				
fresh airns	0.288	29	33	23
Odour-People				
perfumens	0.512	26	20	21
Odour-Food				
coffee**	0.006	11	12	26
spices/herbs***	<0.001	30	34	9
fresh bread **	0.003	3	17	11
grilled foodns	0.526	11	16	15
fast food **	0.007	2	14	9
general foodns	0.064	71	88	72
Odour-Garbage				
garbage can***	<0.001	6	6	31
Odour-Other				
synthetic*	0.025	13	3	8
Sound-Nature				
water flow***	<0.001	1	5	25
Sound-People				
conversation**	0.005	90	100	81
whisperingns	0.664	33	29	27
laughter**	0.002	38	63	40
human noisens	0.408	86	83	91
walking steps**	0.002	66	52	42
clattering footsteps**	0.001	41	22	21
Sound-Indoor				
echo*	0.014	5	4	13
cutlery soundsns	0.715	12	16	11
Sound-Mechanical				
clatter***	<0.001	43	60	73
beepingns	0.097	6	15	9
Visuals-Lightning				
brightns	0.945	75	78	78
natural lightning***	<0.001	12	28	44
artificial lightningns	0.643	72	65	64
Visuals-angle				
flatns	0.597	12	17	14
largens	0.145	30	28	40
spaciousns	0.529	65	63	59
openns	0.898	46	49	48
angularns	0.959	22	22	21
untidy**	0.001	3	1	12
Visuals-Detailing				
clearns	0.054	67	56	53
uniformns	0.246	38	39	29
unclear*	0.030	5	11	17
Somatosensory-Temperature				
coolns	0.322	48	59	47
warmns	0.890	18	15	18
windy/airyns	0.068	36	39	24
standing airns	0.071	17	6	12
body warmns	0.608	16	17	21
Somatosensory-Humidity				
dryns	0.957	63	62	61
Somatosensory-Touch				
lightns	0.277	27	23	18
smoothns	0.886	20	23	21
hardns	0.210	22	36	28

* Indicates a significant difference at $p < 0.05$.
** Indicates a significant difference at $p < 0.01$.
*** Indicates a significant difference at $p < 0.001$.
ns Indicates the non-significant difference between study areas according to Chi-Square.

3.1.4. Wellness in a place

The most often chosen wellness attributes in the restaurant were healthy, peaceful, calm, and stressed, out of 21 possible terms (Table 7). There is a tendency for positive attributes, such as healthy, peaceful, friendly, approachable, and joyful to be selected more often in the lobby and in the dining area, and negative terms at the waste point (e.g., stressed, unfulfilled, tired). The only significant difference between the areas was in the use of the term approachable ($p < 0.05$).

Table 6
F and p-values, mean appropriateness scores, and SD for the areas evaluated.

Response variable	F	p	Lobby entering the restaurant	Dining area	Waste point
Odour appropriateness	1.71	0.184	3.7 ± 0.8	3.8 ± 1.0	3.5 ± 0.9
Sound appropriateness	0.43	0.654	3.4 ± 0.8	3.3 ± 0.9	3.3 ± 0.9
Visual appropriateness	1.76	0.174	3.7 ± 0.7	3.5 ± 0.8	3.6 ± 0.8
Somatosensory appropriateness	0.05	0.954	3.3 ± 0.8	3.3 ± 0.9	3.3 ± 0.9

Table 7
Frequency (in percentage) in which each wellness term of the CATA question was used to measure how consumers feel in the study area.

Term	p Value (Chi-Square)	Lobby entering the restaurant	Dining area	Waste point	Average frequency of use
Healthy	0.384	29	30	23	27
Peaceful	0.262	25	21	16	21
Calm	0.477	19	24	17	20
Stressed	0.060	16	16	26	19
Friendly	0.166	23	20	14	19
Tired	0.558	18	16	22	19
Secure	0.437	21	19	14	18
Approachable	0.013	21	17	8	15
Unfulfilled	0.166	11	13	21	15
Joyful	0.223	17	17	9	14
Relaxed	0.207	8	15	13	12
Refreshed	0.272	7	13	13	11
Energetic	0.239	13	11	6	10
Disconnected	0.538	6	9	7	7
Uninterested	0.348	4	10	8	7
Happy	0.247	10	6	4	7
Fatigued	0.779	5	8	7	7
Lonely	0.867	2	3	4	3
Strong	0.417	3	4	1	3
Sad	0.368	0	0	1	0
Ashamed	0.368	0	0	1	0

3.1.5. Duration of the questionnaire

In total, the respondents used 2–15 min to complete the questionnaire. In the lobby and waste point area, the average time was 4.5 min to complete, but in the dining area, the average time was 7 min. In the dining area, the respondents sat at tables while answering, whereas in the lobby or at the waste point the respondents stood.

4. Discussion

4.1. The possibilities of the Sensory Walk Questionnaire

The Sensory Walk Questionnaire was constructed to measure the overall multi-sensory human experience of a surrounding environment in a structured way. It is the first of its kind to utilize well-defined multi-sensory evaluation practices in the evaluation of surrounding places. The lexicon to characterise places was constructed based on a literature review, complemented in interviews with architects, and tested in a case study in three areas of a restaurant.

The need for such a holistic tool has been identified. Analysing the sensory environment of a place, and the possibility to recognise drivers of liking between different environments is a valuable tool for managing and designing buildings and landscapes. Henshaw & Guy (2015) studied

older people's sensory experiences in private and care-homes and called for a better understanding of the sensory desires of the residents. Quality of life issues for older people can arise from sensory experiences such as "opening the window to breathe in the fresh air, smell the countryside or listen to the sounds of children" and these sensory aspects of a building should be evaluated and considered in the design. It has been already discussed that the focus of architecture is shifting from a more functional role 'the formal properties of the object' to a more experiential role, namely 'the effects it generates for the subject' (Degen, Melhuish, & Rose, 2017). Professor of architect Juhani Pallasmaa writes that "every touching experience of architecture is a multi-sensory; qualities of matter, space, and scale are measured equally by the eye, ear, nose, skin, tongue, skeleton and muscle" (Holl, Pallasmaa, & Pérez-Gómez, 2006). The importance of meaningful places has been recognized in urban landscape design (Liu et al., 2013).

This Sensory Walk Questionnaire gives comparable information to previous place studies, but instead of focusing on one sense, the Sensory Walk Questionnaire measures all the sensory modalities of a place at once. The place experience is multi-sensory and the interactions between the senses have also been recognized i.e., the sense of sight or touch can play a crucial role in the perception of the soundscape (Imschloss & Kuehnl, 2017; Li & Lau, 2020). As the importance of examining the combination of atmospheric cues has been recognized (Imschloss & Kuehnl, 2017), the Sensory Walk measurement would enable the use of multiple regression methods to analyse the relationships between sensory modalities in different environments.

The developed Sensory Walk Questionnaire consists of selected questions and a list of CATA descriptors. The aim was to develop a generalizable questionnaire, which is not place or culture specific. However, we would like to encourage researchers to use local knowledge and to be flexible in adapting the CATA lexicon if some place relevant descriptors are found to be missing. The case study in the self-service restaurant showed that the Sensory Walk Questionnaire can be used to detect differences between different places and to recognise possible incongruent perceptions inside a restaurant. Based on the Sensory walk study, the lobby has a moderate odour intensity, and the perceived odours; general food and spices/herbs characterised, are evaluated as pleasant. The sound intensity was evaluated as moderate, and conversations and walking steps characterise the soundscape in the lobby. Visually the lobby is bright. The described experience in the lobby can act as a good attraction factor for the restaurant.

The dining area in the restaurant was filled with food odours, and the soundscape was characterised by conversation and laughter. Sound intensity was significantly higher in the dining area compared to the lobby, but in this case, the higher intensity did not decrease the pleasantness. This suggests that the type of sound characteristics matter, and if the type is positive, higher intensity can be considered acceptable. In the dining area, the respondents perceived more cool temperatures than warm, which may explain the rather low somatosensory pleasantness of the dining area (average 4.6 on the 7-point scale). The colour of the restaurant is a combination of light blue and light grey, which are typically cold colours and are found to decrease the perceived warmth (Wastiels et al., 2012).

The Sensory walk study revealed significantly lower odour and sound pleasantness scores at the waste point compared to the lobby and the dining area. Sound pleasantness was evaluated as very low (average 3.3 on the 7-point scale) at the waste point. There the sound intensity was evaluated higher than in the dining area, and the sound type was characterised as clatter-type sounds. The waste point gives the last impression of the restaurant, and if the experience is negative, it might affect the future success of the place. One of the study results was that more attention should be paid to the sound environment of the restaurant, especially at the waste point, to improve the sound environment by reducing unpleasant clatter. The case study showed that the Sensory Walk can also identify areas for development that could enhance the pleasantness of a place.

It should be noted that the pleasantness of the same sensory stimulus may carry a positive connotation for one person but might be disliked by another, and in addition, the same stimuli may be appropriate in one place, but not in another (Low, 2015), in addition, the same stimuli may be intense for one person and weak for another. Typically, intense smells have been considered unpleasant (Xiao et al., 2018).

In the in-building restaurant, the selection of the characteristics can be considered predictable, but reflective of consumer experience. Characteristics related to nature or traffic were rarely chosen, but they were not considered distracting, and the choice of terms was not considered too burdensome for the consumers thanks to the CATA block headings, which made it easy to choose appropriate terms.

The characterised sensory environments were found moderately appropriate for each sense. The finding that the different locations were different in sensory characteristics, but on a similar level in terms of appropriateness, supports the idea that appropriateness depends on the place. Xiao et al. (2018) formulated that appropriateness depends on whether perceived smells match the physical and social context of a place. The level of appropriateness is determined mainly by the expectations of the observer. It is also related to the consistency of sensations between the different senses. Garbage can odour was detected at the waste point, and probably influenced odour pleasantness, but the garbage odour can still be found appropriate at the waste point due to the function of the place. If the garbage odour had dominated the lobby instead, presumably it would not have been considered appropriate. The coffee odour was registered most often at the waste point, even if the cafeteria odour could have spread equally throughout the restaurant. The explanation for this could be that a cup of coffee was planned to be enjoyed right after lunch, so respondents became more sensitive to the smell of coffee when the time was appropriate. Oberman et al. (2020) studied soundscapes with different musical features in public spaces and found that an added right sound influenced both the pleasantness and appropriateness of the overall acoustic environment. Xiao et al. (2018) considered appropriateness and liking as the primary indicators in smellscapes, whereas Mathiesen et al. (2022) found that the appropriateness and liking of the sonic atmosphere positively correlated with the overall pleasantness of the experience.

The restaurant's wellness profile was determined in the end. The average percentage of wellness terms used varied from 0 % to 27 %, meaning that some terms were not used at all (sad, ashamed), whereas others were used one of every fourth or fifth response (healthy, peaceful, calm). However, the profile was very similar in each area. Wellness evaluation was conducted by using the lexicon from The WellSense Profile™ (King et al., 2015), and the terms considered and tested as appropriate for the evaluation of the environment were used (not published). The original wellness questionnaire uses a category scale for measuring wellness terms, but a CATA variant of a similar type of questionnaire has been previously applied in the home-use test (Jaeger et al., 2018). Here the wellness measurement can be considered to give overall information about the respondents in the restaurant, but a low number of selected wellness terms diminishes the ability to discriminate differences between the locations. The well-being created by the built environment is likely to be a very central research question in the future, although this time in a busy lunch restaurant no differences were found between the different locations. Rephrasing the wellness question, the exact terms used, or the number of terms could also be considered to enhance the discrimination.

This study showed that The Sensory Walk questionnaire could be useful to identify sensory experiences and develop different environments, such as public spaces, and places for well-being, working and learning. There would be a lot of potential in recognizing different sensory environments in buildings, and city areas, and then informing visitors about the sensory experiences to help people find places they find pleasant, for example, urban quiet areas (Radicchi et al., 2018). It has been shown, that e.g., smells can become synonymous with a particular place and woven into the collective memory and

understanding of its residents and visitors (McLean, 2017). This, in turn, may trigger emotional nostalgic reactions (Henshaw et al., 2015). The sensory data could be used for marketing purposes i.e., sensory marketing of places. The recognized sensory stimuli can be used as a presentation of the city as has been done for example in the case of Smellmap of Amsterdam (McLean, 2017). Perceptual maps of the cities have been constructed also for soundscapes in Barcelona, in the UK (Aiello et al., 2016b; Kang et al., 2018), Berlin (Radicchi et al., 2018), and in China (Liu et al., 2013).

Also, for sensory research professionals, it would be useful to understand the characteristics and differences of test locations, especially when different test facilities, e.g., sensory laboratories, immersive test rooms, and real-life test settings are nowadays possible (Delarue, Brasset, Jarrot, & Abiven, 2019; Holthuysen, Vrijhof, de Wijk, & Kremer, 2017).

A possible application of the Sensory Walk questionnaire is also when virtual and augmented reality environments are built. The key characteristics of a real environment can be recognized and measured using the questionnaire, and the similarity of sensory experience can be measured while building the environment or experience digitally. Sona et al. (2019) studied the restorative potential of sensory-enriched break environments and found that a sensory-enriched congruent multisensory (vision, audition, and olfaction) environment can facilitate the recovery of personal resources. They found, that using an additional congruent scent enhanced the room pleasantness of the simulated audiovisual environment and indirectly intensified the recovery effects on mood, arousal, and reduced fatigue. Possible applications for enriched sensory environments are also museums (Vi, Ablart, Gatti, Velasco, & Obrist, 2017; Xiao et al., 2021).

4.2. Limitations and further studies needed

Measuring the multi-sensory and dynamic environment is new. Limitations can be recognized in the lexicon. Selecting, and categorising the vocabulary was a balancing act leaning heavily on previous consumer studies. The aim was to build a lexicon that would be as generalisable as possible, suitable for a wide range of locations and used both indoors and outdoors. Nevertheless, it is recommended to pilot test the suitability of the suggested vocabulary in a new location or to leave the possibility for open comments. The research group encourages editing the terms with more appropriate or culture-specific terms when they are recognised, such as tar being recognised as important in Finland. The actual wording of sight-related terms was considered the most difficult, despite the role of the sense of sight in architecture.

It should also be noted that sensory environments are typically dynamic, and differences in evaluators' assessments can be due to sudden changes in a place. However, we see that the places have typical characteristics that the Sensory Walk Questionnaire is well able to recognize and measure.

Here, in the pilot study, we compared the evaluations of three consumer groups in three locations, but another possible approach could be to use one assessor group to evaluate several different places, as consumers evaluate the sensory quality of several food products in CLT.

5. Conclusion

The study aimed to develop a multi-sensory evaluation questionnaire for place evaluation and to conduct a first-of-its-kind sensory evaluation in a restaurant. The aims were achieved, and the tool gives a broad understanding of the sensory experience in a place and can identify developmental needs. The Sensory Walk questionnaire is valuable in characterizing different places, and the results can be used to analyse environmental factors affecting food choices or taste, develop more sensory-pleasant environments, and market the properties of places. A need for additional studies regarding different places is recognized.

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CRediT authorship contribution statement

Terhi Pohjanheimo: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Pauliina Ojansivu:** Conceptualization, Funding acquisition, Writing – review & editing. **Anu Hopia:** Conceptualization, Writing – review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

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