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DEVELOPING DESCRIPTORS FOR INDOOR SOUNDSCAPE AND LIGHTSCAPE IN PUBLIC SELF-LEARNING SPACES

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Abstract

Public self-learning spaces are high-cognitive-demand indoor environments in which experience is shaped by multiple perceptual factors rather than by sound or light alone. However, questionnaire-oriented perceptual descriptors for indoor soundscape and lightscape in such spaces remain limited. This paper reports a preliminary part of Phase 1 of a larger doctoral study. Although the broader focus-group design includes both Chinese- and English-language groups, this paper reports only the three Chinese-language groups that have been organised and analysed so far. It addresses one central question: which perceptual descriptors can be preliminarily identified and organised into a questionnaire-oriented wording list for indoor soundscape and lightscape in public self-learning spaces? Across the three Chinese-language focus groups analysed so far, participants showed a qualitatively recurring shared preference for environments characterised by low disturbance, appropriate visual conditions, comfort, safety, and concentration support. The findings provide a preliminary descriptor basis for later pilot testing and questionnaire attribute selection, rather than a final validated perceptual model.

Keywords: indoor soundscape, lightscape, perceptual descriptors, public self-learning spaces, focus groups

1. INTRODUCTION

1.1 Study context and spatial definition

Libraries are no longer used solely for borrowing books or for general reading in traditional reading rooms. Previous studies have shown that academic library spaces have gradually shifted from places centred on collection storage and information access to more complex learning environments that support learning, research, and teaching [1,2].

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At the same time, students increasingly regard the library as an important study space and use it for individual study, group study, and other forms of self-directed academic activity [3]. In higher education research, such spaces are also often discussed within the framework of informal learning spaces and are defined as non-discipline-specific spaces for self-directed learning activities by students and staff, located either inside libraries or elsewhere in the campus learning environment [4]. Research on higher-education learning-space preferences and university or academic-library space experience also indicates that students' study-space choices can involve spatial support, comfort, familiarity, and affective attachment to academic library environments [5-7].

Against this background, the present study further defines those indoor learning environments that are public in nature, support self-directed learning, and are mainly used for sustained reading, writing, thinking, revision, and information processing as public self-learning spaces. This concept emphasises not simply spatial openness, but a learning setting in which individual cognitive work takes place in a public environment. Compared with classrooms, open-plan offices, or traditional reading rooms, public self-learning spaces usually involve greater autonomy, longer duration of stay, and higher cognitive engagement. Public self-learning spaces therefore overlap with open-plan offices in that both are indoor shared environments where users undertake concentration-related activities. However, the present study treats public self-learning spaces as a specific learning context because the activities considered here are self-directed learning activities, such as reading, writing, revision, thinking, and information processing. The focus is therefore not on workplace performance or office satisfaction, but on perceived suitability for sustained self-learning. For this reason, descriptors developed in office soundscape research are relevant points of reference, but they still require contextual examination before being used as questionnaire wording in public self-learning spaces.

1.2 Conceptual basis and research gap

In acoustics research, ISO 12913-1 defines soundscape as the "acoustic environment as perceived or experienced and/or understood by a person or people, in context," making clear that the evaluation of a sound environment should be understood within the relationship between person, environment, and context [8]. ISO/TS 12913-2 further sets out requirements and supporting information for soundscape data collection and reporting [9]. Within this framework, soundscape research has gradually moved away from a traditional noise-control paradigm toward an approach centred on perceptual evaluation.

The paper does not assume that lightscape has an ISO-equivalent official English definition comparable to the ISO soundscape definition. In this paper, lightscape is therefore used as an operational term to refer to users' perceptual and evaluative experience of the luminous environment in relation to self-learning suitability. This wording is used to clarify the scope of the present study, rather than to propose a universal definition of lightscape.

At the methodological level, Axelsson et al. used perceptual attributes and principal components analysis to develop a model of soundscape perception, showing that descriptor-based responses can be organised into perceptual dimensions [10]. Torresin et al. later extended descriptor-based soundscape assessment to indoor residential environments, further showing that indoor acoustic perception can be organised through interpretable perceptual attributes [11]. More recently, West et al. developed an office soundscape assessment model for open-plan offices, showing the relevance of affective soundscape evaluation in indoor work environments [12]. This study is particularly relevant to the present paper because open-plan offices and public self-learning spaces both involve shared indoor settings and concentration-related activity. However, the aim of the present paper is not to propose a competing indoor soundscape model. Rather, it examines whether questionnaire wording for soundscape and lightscape evaluation needs contextual adaptation when the setting is public self-directed learning rather than office work. Therefore, overlap with existing indoor soundscape descriptors is expected, especially around calmness, low disturbance, and pleasantness, while additional learning-space and light-related descriptors may also need to be considered.

However, although previous work has separately developed knowledge on library learning spaces, learner space preferences, indoor soundscape evaluation, and luminous-environment appraisal, current research has not yet established a set of questionnaire-ready perceptual descriptors that can be directly used in public self-learning spaces and that jointly cover indoor soundscape and lightscape-oriented experience. In other words, the limitation of existing research lies not only in the limited number of available descriptors, but also in the lack of a perceptual wording system that can connect with existing theoretical frameworks, reflect real user language, and support later questionnaire design and dimensional modelling.

1.3 Aim of the present study

The present paper reports a preliminary part of Phase 1 of a larger doctoral study and focuses on wording-list development rather than final model construction. The broader focus-group design includes both Chinese- and English-language groups; however, at this stage, only the three Chinese-language groups have been fully organised and analysed. Accordingly, this paper addresses one central research question: which perceptual descriptors can be preliminarily identified and organised into a questionnaire-oriented wording list for indoor soundscape and lightscape in public self-learning spaces, based on the analysed Chinese-language focus groups? The English-language materials and cross-language comparison will be addressed in subsequent work and are not used as the basis for the substantive findings reported in this paper. To address this question, the study combines literature-informed initial screening with focus group elicitation, discussion, and wording-list refinement, with the aim of developing a preliminary descriptor structure for subsequent pilot and field questionnaire design.

2. METHODS

2.1 Study design

This study adopted a literature-informed focus group design. Focus groups are well-suited to examining how participants form, compare, and revise their understanding around a given topic, and they are also appropriate for identifying natural wording and shared meanings in a specific context [13,14]. As the present study does not aim at this stage to directly validate a final perceptual dimensional model of indoor soundscape and lightscape in public self-learning spaces, but rather to establish an initial wording basis for later questionnaire item development, literature-informed screening and focus groups were combined. An initial pool of soundscape and lightscape attributes was first derived through literature review, and these descriptors were then generated, revised, and screened through focus groups. This design is also consistent with the general logic of scale development, in which item development precedes later testing and reduction [15].

2.2 Participants and recruitment

The broader focus group design included two language contexts and six groups in total, with one acoustics-related group, one lighting-related group, and one general-user group in each language context. Each group was planned to include around six participants, giving a total of 36 participants. Participants were aged 18 or above and included students, teachers, and staff. No restrictions were placed on cultural background or ethnicity.

In each language context, the acoustics-related group referred to participants with education, research experience, or professional familiarity in acoustics, soundscape, or environmental sound. The lighting-related group referred to participants with education, research experience, or professional familiarity in

lighting, visual environment, or architectural/environmental design related to light. The general-user group referred to regular users of public self-learning spaces who were not recruited as acoustics or lighting specialists. This group was included to capture everyday user language and to examine whether candidate descriptors were understandable outside specialist communities. In the present paper, only the three Chinese-language groups are reported.

Participants were recruited through university mailing lists, Google Forms, WeChat groups, and snowball referral. Before participation, all participants read the participant information sheet and signed the informed consent form.

2.3 Procedure

The focus groups followed a semi-structured format and were conducted online via Microsoft Teams. Mentimeter was used to support individual written elicitation, and Google Forms was used for the later wording-list screening stage. The procedure consisted of four connected components.

First, participants completed individual written elicitation tasks. They were asked what mattered to them when choosing a public self-learning space, what examples of such spaces they could identify and why, how they would describe the overall perceptual experience, and how they would describe the sound environment and lighting environment separately. This stage was conducted before group discussion in order to preserve spontaneous wording and reduce conformity effects.

Second, participants discussed and revised their responses after seeing other participants' answers. The discussion addressed whether their views had changed, which words were inaccurate or unsuitable, which terms needed clarification, which spaces or seats they would avoid, and under what circumstances they would move to another place. This stage was used to clarify meanings, identify ambiguous terms, and understand the contextual conditions behind the descriptors.

Third, participants completed a Google Form wording-list screening task. In this task, they judged whether pre-organised candidate descriptors were more applicable to the sound environment, the lighting environment, both domains, or neither, and they were invited to add further descriptors. The Google Form was treated as a supplementary screening tool within the focus-group process, rather than as an independent quantitative validation of the descriptor structure.

Fourth, participants were asked to summarise what they thought mattered when people choose a place for self-learning. This final reflective question was used to check whether the emerging interpretation of space choice was consistent with participants' own summary of the discussion.

2.4 Data collection and processing

With participants' consent, all discussions were recorded via Microsoft Teams and automatically transcribed. Researcher notes, Mentimeter responses, Google Form outputs, and other procedural outputs were also retained. Because the automatic transcripts contained substantial errors, especially in the Chinese-language groups, they were used only as preliminary records. The analysis therefore relied mainly on repeated listening, screen-recording review, and researcher notes.

The analysis was conducted as a qualitative descriptor-screening process. First, words and phrases referring to environmental perception, acoustic experience, lighting experience, spatial preference, and self-learning suitability were extracted from the individual elicitation responses. Second, these initial expressions were compared with the discussion transcripts to identify how participants explained, revised, rejected, or redefined them. Third, semantically similar expressions were grouped while retaining user-facing wording where possible. For example, expressions related to quietness, calmness, and lack of interruption were grouped as quiet/calm/undisturbed, whereas lighting-related expressions such as brightness, uniformity, glare, direct light, and shadowing were retained as more specific descriptors. Fourth, the Google Form outputs were used to check whether candidate descriptors were perceived as sound-related, light-related, shared across both domains, or unsuitable. Finally, the resulting descriptors were organised into three levels: core questionnaire candidates, sub-dimensional descriptors, and context-dependent or optional terms.

Core questionnaire candidates were terms that were repeatedly present in the analysed Chinese-language materials, directly relevant to self-learning suitability, and potentially understandable to non-specialist respondents. Sub-dimensional descriptors were terms that captured more specific perceptual mechanisms within sound, light, or spatial-social experience. Context-dependent or optional terms were terms that were meaningful in discussion but were not retained as core items at this stage because they were more preference-dependent, individual-state-related, technical, group-specific, or semantically unstable.

2.5 Methodological considerations

The methodological design followed several considerations. Because public self-learning spaces involve multiple environmental cues, the discussion began with overall space experience before moving to sound and light specifically. Literature-based descriptors were treated as a candidate pool rather than presented at the outset as fixed questionnaire items, so that more natural and context-relevant wording could emerge. Individual elicitation was conducted before group discussion to preserve spontaneous responses and reduce conformity effects. The online combination of Microsoft Teams, Mentimeter, and Google Forms also supported stratified grouping and systematic recording of the process. The Google Form component was used to support descriptor screening within the focus-group procedure, but it was not intended to provide independent statistical validation. At this stage, the purpose was not to validate a

final perceptual model, but to develop a preliminary questionnaire-oriented wording structure through elicitation, discussion-based clarification, supplementary wording-list screening, and cross-group synthesis [13-15].

3. RESULTS

3.1 Cross-group consistency

Across the three analysed Chinese-language groups, low acoustic disturbance was repeatedly identified as important for public self-learning spaces. However, participants did not judge the suitability of a space for self-learning by quietness alone. Instead, they combined acoustic conditions with visual suitability, physical comfort, safety, convenience, spatial arrangement, and a study-supportive atmosphere. In this paper, factors such as smell, temperature, Wi-Fi, distance, price, toilets, drinking water, or seating facilities are not treated as target soundscape or lightscape descriptors in themselves. Rather, they are interpreted as contextual factors that shape whether users judge the acoustic and luminous environment to be acceptable for sustained study.

Their descriptions of preferred spaces also converged around a qualitatively recurring set of positive meanings: quiet or calm, undisturbed, bright or visually suitable, comfortable, safe, focused or immersive, and relaxed or peaceful. These meanings formed the basis for the preliminary core questionnaire candidates.

3.2 Sound-related, light-related, and shared experiential descriptors

For the sound environment, participants consistently referred to quietness, calmness, low disturbance, and the ability to ignore background sound. However, the discussion also showed that absolute silence was not always preferred. Several participants described acceptable background sound, white noise, or low-level continuous sound as compatible with concentration, while sudden, intelligible, sharp, or socially intrusive sounds were more likely to cause distraction. This supports the retention of suddenness, continuity, background level, intelligibility, and social intrusion as candidate sound-related sub-dimensions.

For the lighting environment, participants repeatedly referred to brightness, sufficient illuminance for reading, evenness, low glare, avoidance of direct light, shadowing, and colour temperature appropriateness. Lighting was not described only as a physical condition, but also as a contributor to alertness, visual comfort, relaxation, and study suitability. This supports the retention of brightness, uniformity, glare, directness, and colour temperature appropriateness as candidate light-related sub-dimensions.

A third group of descriptors crossed sound and light boundaries. Comfortable, safe/secure, focused/immersive, and relaxed/peaceful were not tied to a single sensory modality. Instead, they described the overall suitability of the environment for sustained self-learning. These terms were therefore treated as shared experiential descriptors rather than as purely acoustic or purely luminous attributes.

3.3 Function of group differences in descriptor development

The differences between the three groups should not be interpreted simply as evidence that the acoustics-related group discussed sound and the lighting-related group discussed light. The groups were intentionally stratified by background, and their analytical value lies in how they contributed differently to descriptor development.

The acoustics-related group provided more fine-grained sound-related distinctions, including disturbance, background sound, balance, suddenness, intelligibility, social intrusion, white noise, and acoustically variegated conditions. These responses helped identify possible sound-related sub-dimensions, although some technically precise terms were not suitable as core questionnaire wording.

The lighting-related group helped separate visually related concepts that might otherwise be merged under a general term such as “comfortable lighting”. Participants distinguished brightness, uniformity, glare, direct light, shadowing, colour temperature, and the visual suitability of light for reading or study. This group therefore contributed to the refinement of candidate light-related sub-dimensions.

The general-user group contributed more everyday and situation-based expressions. Participants in this group referred more frequently to smell, safety, price, Wi-Fi, distance, facilities, seating, and whether other people were present. This group was particularly important for checking whether candidate descriptors were natural and understandable for non-specialist respondents. The group comparison therefore functioned as a qualitative wording-screening step: specialist groups helped refine perceptual distinctions, while the general-user group helped assess everyday interpretability.

3.4 Preliminary descriptor structure for questionnaire development

Based on the integrated analysis of individual elicitation, group discussion, Google Form wording-list screening, and final participant summaries, the preliminary descriptor structure was organised into three levels. The first level consists of core questionnaire candidates. These terms were repeatedly present in the analysed Chinese-language materials, directly relevant to self-learning suitability, and appeared suitable for later questionnaire wording. The second level consists of candidate sub-dimensional descriptors. These terms describe more specific perceptual mechanisms behind the core judgements. The third level consists of context-dependent or optional terms. These terms were meaningful in discussion but were not retained as core questionnaire candidates at this stage because they were more preference-dependent, individual-state-related, technical, group-specific, or semantically unstable.

Table 1. Preliminary core questionnaire candidates for public self-learning spaces

Domain	Descriptor	Why retained
Soundscape	quiet/calm/undisturbed	Repeatedly present in the analysed materials; directly reflects low disturbance and concentration support
Luminous/lightscape	bright/evenly lit/glare-free	Repeatedly present in the analysed materials; directly reflects visual usability for study
Shared experience	comfortable	Linked to physical comfort and longer stay
Shared experience	safe/secure	Includes both physical security and psychological reassurance
Shared experience	focused/immersive	Directly reflects the task-oriented nature of self-learning spaces
Shared experience	relaxed/peaceful	Frequently mentioned as a desirable low-pressure study condition

Table 2. Candidate sub-dimensional descriptors and their perceptual meanings

Domain	Sub-dimension	Interpretive meaning
Soundscape	suddenness	Whether sounds occur abruptly and interrupt attention
Soundscape	continuity	Whether the acoustic background is stable and predictable
Soundscape	background level	The overall level of ongoing background sound
Soundscape	intelligibility	Whether surrounding speech can be clearly understood
Soundscape	social intrusion	The degree to which others' activities interfere with study
Luminous/lightscape	brightness	Overall perceived light level
Luminous/lightscape	uniformity	Evenness of light distribution
Luminous/lightscape	glare	Presence of visual discomfort caused by bright light
Luminous/lightscape	directness	Whether direct light or shadowing becomes distracting or visually uncomfortable
Luminous/lightscape	colour temperature appropriateness	Whether the colour tone of light is suitable for study
Space/social	privacy	Degree of enclosure or visual shielding
Space/social	exposure	Degree of being seen, watched, or interrupted
Space/social	familiarity	Sense of routine, control, and environmental familiarity
Space/social	crowding	Perceived density of people and spatial pressure
Space/social	learning vibe	Whether the space conveys a study-supportive atmosphere

Table 3. Context-dependent or optional terms not retained as core questionnaire candidates at this stage

Term	Reason for not retaining as a core item	Suggested treatment
cheerful	More outcome-like and not consistently relevant to concentrated study	Keep as an optional term
inspiring	Valuable but semantically less stable	Test further in pilot work
sleepy	More reflective of individual state than stable environmental quality	Do not retain as a core item
socially porous	Insightful but difficult for non-experts to interpret consistently	Retain only as an analytical term
acoustically variegated	Too technical and background-dependent	Do not use directly in the questionnaire
white noise	Meaningful but strongly context- and preference-dependent	Test further before retention
warm/cool	More preference-dependent than universally stable	Consider only under more refined light-related testing

4. DISCUSSION

The findings should be interpreted as a preliminary step in context-specific descriptor development, rather than as evidence for a final perceptual model. Across the three analysed Chinese-language focus groups, quietness and low disturbance remained central to acoustic evaluation. However, participants' judgements of whether a space was suitable for self-learning also depended on visual suitability, physical comfort, safety, convenience, and a study-supportive atmosphere. Therefore, the statement that public self-learning spaces should not be understood through quietness alone does not mean that quietness is unimportant, nor does it mean that all contextual factors are part of the soundscape or lightscape construct. Rather, it means that questionnaire wording for this context should capture both modality-specific descriptors and shared experiential descriptors.

This interpretation also clarifies the relationship between the present study and recent indoor soundscape work on open-plan offices. West et al. showed that open-plan office soundscape perception can be examined through affective soundscape assessment in an indoor work setting [12]. Public self-learning spaces share some characteristics with open-plan offices because both involve cognitively demanding activities in shared indoor environments. Accordingly, overlap is expected, particularly in descriptors related to calmness, low disturbance, pleasantness, and concentration support. However, the present paper does not aim to propose a competing model. Its contribution is to examine how questionnaire wording may need to be adapted when the context is public, self-directed learning and when both acoustic and luminous conditions are considered.

The findings are also in line with the contextual perspective of soundscape research, which emphasises that environmental evaluation should be understood through the person-environment-context relationship rather than through isolated physical indicators alone [8,9]. In this respect, the present study is broadly consistent with earlier descriptor-based soundscape research, including the perceptual model proposed by Axelsson et al. [10], later indoor soundscape work by Torresin et al. [11], and the descriptor-oriented framework discussed by Aletta et al. [16]. However, unlike these studies, the present paper does not aim to derive a final perceptual structure at this stage. Rather, it identifies and preliminarily organises a set of questionnaire-oriented descriptors for public self-learning spaces, while retaining light-related distinctions that are consistent with broader classroom environmental-quality research covering thermal, acoustic, and lighting comfort [17], and with studies of luminous environment appraisal and lighting quality in higher-education classrooms [18,19].

The stratified focus-group design helped distinguish between specialist precision and everyday questionnaire wording. The acoustics-related and lighting-related groups generated more precise perceptual distinctions, while the general-user group provided everyday expressions and revealed which words may be more understandable for non-specialist respondents. This is important because a descriptor that is conceptually useful is not necessarily suitable as a survey item. Terms such as socially porous and acoustically variegated were therefore retained only as analytical or optional terms, while more accessible terms such as quiet, undisturbed, bright, glare-free, comfortable, safe, focused, and relaxed were retained as core questionnaire candidates.

Several limitations should be noted. First, although the broader doctoral study includes both Chinese- and English-language focus groups, the present paper reports only the three Chinese-language groups that have been organised and analysed so far. The findings are therefore preliminary and language-context specific. Second, the Google Form wording-list task was used as a supplementary screening tool within the focus-group process, not as an independent statistical validation. Third, the descriptor structure proposed here still requires pilot questionnaire testing and later field-study validation before it can be treated as a stable perceptual model.

5. CONCLUSION REMARKS

This paper reported a preliminary part of Phase 1 of a larger doctoral study and focused on questionnaire-oriented descriptor development for indoor soundscape and lightscape in public self-learning spaces. Based on the three analysed Chinese-language focus groups, the study identified a preliminary descriptor structure consisting of core questionnaire candidates, candidate sub-dimensional descriptors, and context-dependent or optional terms. Quietness and low disturbance remained central to acoustic evaluation, but participants' judgements of self-learning suitability also involved visual suitability, comfort, safety, concentration support, and a study-supportive atmosphere. The main contribution of the paper is therefore the preliminary organisation of user-informed descriptor wording for later questionnaire development, rather than the validation of a final perceptual model. Future work will analyse the remaining language-context materials, test the descriptors through pilot questionnaires, and examine their dimensional structure in field studies.

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