

UNDERSTANDING SOUND EXPERIENCES AT WORK: A DIARY STUDY IN OPEN-PLAN OFFICES

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Abstract

Noise is a persistent issue in open-plan offices, and perceived annoyance can be partly explained by temporal and spectral variations of the soundscape. While acoustic treatments and sound masking systems help to reduce the ambient noise level and speech intelligibility, they do not address those variations. Recently, augmented approaches have been investigated to enhance indoor soundscapes by adding spectrotemporal-adaptive signals designed to transform the soundscape rather than mask it. To explore the relevance of such approaches, we sought to gain consistent insights about people's relations to the soundscape of their workspace. This paper presents a human-centred methodology in which participants reported their lived experiences through a diary, and talked about their observations and feelings during semi-structured interviews. Data collected from the diaries revealed speech to be the most frequently perceived sound source, although it was not always badly perceived. Affective judgments such as annoyance and pleasantness appeared to be partly explained by noise sources' loudness, relevance and frequency over time. The most efficient coping strategy, and the most widely used, was found to be listening to music through earphones. This supports the relevance of augmented approaches.

Keywords: *sound experiences, open-plan offices, diary study, soundscape research*

1. Introduction

In the service sector, the majority of employees work in open-plan offices. While this type of workspace promotes better communication and offers reduced construction costs, proximity between workers doing different types of activities causes significant noise annoyance that researchers have sought to characterize.

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With the development of a questionnaire to assess employee satisfaction, Pierrette et al. showed the annoyance was felt to be significantly related to the perceived noise level and frequency over time of specific sound sources, such as conversations and ringing telephones [1]. Chevret later proposed a four-step evaluation process to assess workers' annoyance, including observation of the workspace, analysis of activity, evaluation of employees' perception, and evaluation of workspace acoustics [2]. These studies led to consideration of a variety of solutions, primarily installing acoustic treatments to correct the acoustics of the site, better adapting the layout of the area to the activity of the workers [2], and using sound masking systems to reduce speech intelligibility [3]. However, such solutions are passive, or only level-adaptive, and do not address the temporal and spectral variations of the soundscape [2]. Recently, Solorio et al. conducted a study where speech-shaped natural sounds were found to have positive effects on both subjective and objective measures when added to simulated soundscapes in open-plan offices [4]. These findings suggest further investigation of spectral-adaptive approaches.

In a larger frame, we performed a field study of sound perception at work to inform the design of a spectrotemporal-adaptive augmented approach that could improve open-plan office soundscapes [5]. We wanted to investigate the negative and positive perceptive aspects of sounds and people's behaviors towards noise in open-plan offices. This paper reports on the first findings of the field study. The diary-interview methodology considered the first three steps of Chevret's evaluation process [2] and invited participants to immerse themselves in the soundscape of the workspace and verbalize their experiences (See Section 2). Diary entries (Section 3) confirm part of the literature, while opening up new perspectives in soundscape research for open-plan offices, that shall be further investigated with a thematic analysis of the interviews (Sections 4 and 5).

2. Methods

2.1. Study design

A diary-interview methodology [6] was chosen to engage participants' thinking about their sound experiences at work and to fit their schedules.

2.1.1. Diary

A diary was presented in a paper format, in a toolkit containing some supplementary material [5] to invite participants to go through the following tasks:

- Task 1: participants observed their current workspace by drawing its layout, listing the activities they do and giving their opinion about different areas.
- Task 2.a: they listed the sound sources they can hear and expressed a positive, negative or neutral feeling towards each sound, first with a colored sticker (green, red or yellow), and then with free explanations.
- Task 2.b: they reported each time they felt disturbed by sound by documenting their feelings and their strategy to refocus on their work. Later in the day, they could say whether or not their strategies worked.
- Task 3: they described and eventually drew what they would see, hear, and feel in their ideal workspace.

2.1.2. Interviews

Semi-structured interviews were conducted with each participant, during which a common question was asked to introduce each task, and personalized questions helped to gather details about participants observations. After all tasks were discussed, a common question was asked to conclude whether or not noise in the workspace represents an issue for each participant.

2.2. Investigated workspaces

Seven different workspaces were investigated: four coworking areas in Paris, a company in Paris and a company in Neuilly-sur-Seine, and a laboratory in Nantes. Due to practical reasons, no measurements were conducted in these workspaces, but observations of the general acoustics were made during site visits:

- All coworking areas looked out onto the street, and had no acoustic treatment. People went through the reception area and paid to work in the open-plan office, book a closed room, or simply have a coffee.
- One company had two separated open-plan offices, a meeting room, a callbox and a break room in a Haussmannian building with no acoustic treatment.
- The other company had a large open-plan office with a carpeted floor, panels installed between workstations, and furniture that created smaller areas. Many meeting rooms with glass walls were available.
- The laboratory's open-plan office had room for approximately eight people and was accessible from a corridor. The floor was carpeted, but the workspace was separated from other offices by very thin walls. Finally, none of the open-plan areas had a sound masking system installed.

2.3. Participants

Twenty four people (14 women, 10 men) took part in this study. Their age distribution ranged from 21 to 45 (median age 25). Before the beginning of the study,

14 of them indicated they mainly do individual tasks, while 10 specified they do both individual and collective tasks. They also rated the overall pleasantness of their workspace, and their difficulty concentrating, using two separate 5-point Likert scales. Responses to both metrics showed unimodal distributions, and the participants generally rated their workspace as pleasant (median=4, mean=4.2, SD=0.9), with low difficulty concentrating (median=2, mean=2.3, SD=1.0). Interestingly, these global ratings will be modulated by the results presented below.

2.4. Procedure

The study was designed to last from three to five weeks, during which the participants went through an immersion period, an incubation period and a reactivation period. As shown in Fig. 1, participants first provided self-reports by completing the diary during the workday, and the interview was scheduled for a few days after collecting their diaries, so that participants could recall the experiences they described. The incubation period between those two stages was important as participants could reflect on their experiences with the diaries. The researchers used that time to conduct a first analysis of the diaries and to prepare personalized questions for the interviews.

2.5. Analysis

The diaries and interviews were transcribed into text files to be analyzed using QualCoder, a qualitative data analysis software [7]. A thematic analysis is performed on the diaries and interviews by two of the authors using a hybrid approach [8]. As of the date of writing of this paper, only data from the diaries were coded following a theoretical approach, for which various categories were identified to report different types of areas, tasks, sounds and strategies mentioned by the participants. In particular, sound categories and types of coping strategies were inspired by the literature [9], [10]. An inductive approach will be used to code the interviews, and will allow us to report and summarise participants verbalizations.

3. Results

This section presents the results from the diaries and contains quotations that were translated from French (the language of the study) into English by the first author supervised by an English native colleague.

3.1. Description of the work environment

In Tasks 1 and 3, participants described their current and ideal workspaces with various descriptors. For example, P01 reported about their current workspace: *"Cosy, noisy, very airy, not very bright."*

Fig. 2 shows that the most cited characteristic for both tasks is *Sound*. Participants described their current workspace as either calm or noisy, and expressed their opinion regarding some specific elements, as P11 did about meeting rooms: *"It's very practical, as we all have a lot of meetings. The only downside is that the soundproofing might not be very good."*

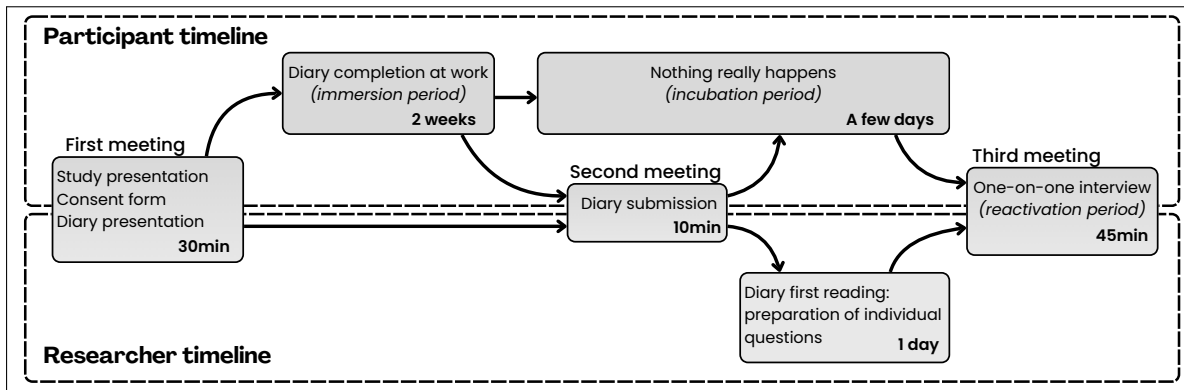


Figure 1: Study procedure flowchart showing the different stages undergone by participant and researcher, from diary reception to the interview, with durations for each step.

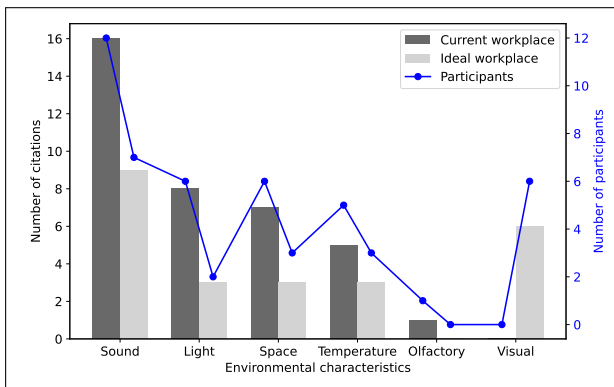


Figure 2: Environmental characteristics mentioned by the participants in Tasks 1 and 3.

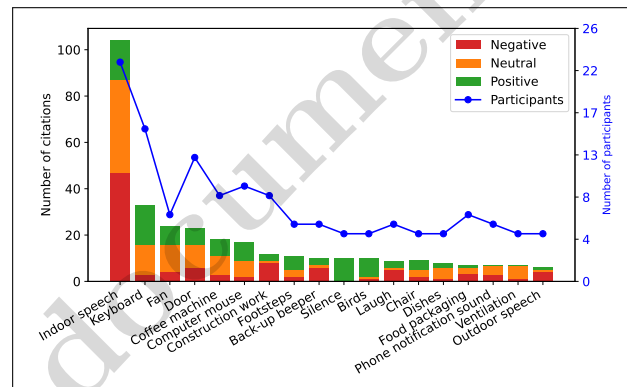


Figure 3: Participants' overall feeling about the most cited sound sources in Task 2.a.

Some participants also proposed some sound improvements for their ideal workspace, as P08 did: "[...] I'd like materials that deaden noise even more, so I'm not distracted by distant conversations."

While the *Light*, *Space* and *Temperature* aspects are almost equally cited for current and ideal workspaces, the *Olfactory* aspect is only mentioned for the current workspace by one participant, suggesting a particular sensitivity. On the contrary, the *Visual* aspect is reported by six participants in their ideal workspace only. Thus, participants would personalize their workspace with some visual elements to improve it, which is more a matter of comfort than necessity, as this aspect was not mentioned for the current workspace.

3.2. Perceived sound sources

In Task 2.a, participants listed sound sources they could hear while working. They assigned 405 colored stickers to specific sources or groups of sources to report their positive, neutral or negative feelings. In all, 465 sound sources were counted, and the ones cited most often are shown in Fig. 3.

Twenty three participants mentioned *Indoor speech* in this task, with a total of 104 citations. This sound source included intelligible and unintelligible speech, conversations, and calls. *Keyboard*, *Fan*, *Door*, *Coffee*

machine, and *Computer mouse* follow, cited between 33 and 17 times. However, the number of participants who cited those sources could vary, and 7 participants from the same workspace cited the *Fan* sound as they had a problem with high indoor heat at the time of the study. This supports the observation that open-plan offices soundscapes can be characterized by some typical sources, but remain very different from one workspace to another. In addition, some participants reported *Silence* as a source, P18 explained: "Two people in total in the open-plan office. Complete silence." This shows the investigated workspaces could be very calm, and only *Silence* was strictly positively rated, while almost all other sounds were associated with the full range of feelings (positive, neutral and negative). This suggests that the subjective effect of perceiving a sound source can not be explained only by the nature of the source. Hence, participants' descriptions of the perceived sound sources were analyzed to better understand the causes of the reported feelings.

3.3. Description of the perceived sound sources

After assessing each sound using the colored stickers, participants explained their evaluations in their own words. These free-text explanations were qualitatively coded into descriptors that represent semantic dimen-

sions and do not carry an intrinsic positive or negative meaning. Consequently, a descriptor may be associated with different feelings depending on the context in which it is used. Overall, the 405 reported sounds yielded 590 coded descriptor occurrences. Fig. 4 shows the frequency of occurrence of the most commonly used descriptors together with the overall feelings assigned to the corresponding sound.

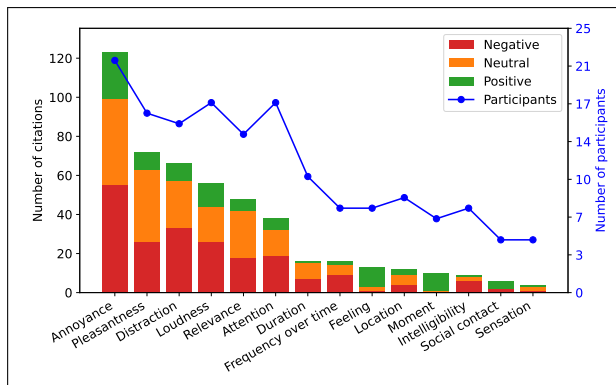


Figure 4: Descriptors used by the participants in Task 2.a to describe the sounds they hear at work.

Participants first tended to give a subjective judgment of the sounds, like P09 did: *"I don't like those mouth noises..."* Such descriptions were associated with affective descriptors such as *Annoyance*, *Attention*, *Pleasantness*, and *Distraction*. Among them, *Annoyance* was the most frequently used. Although it was predominantly associated with negative evaluations (45%), it also appeared in neutral (36%) and positive (19%) descriptions, meaning that participants sometimes explicitly described sounds as not annoying. P05 said about the sound of the front door: *"Nothing to report, it doesn't really disturb me."*

Second, participants described acoustic aspects of the sounds, as P19 did for a phone notification sound: *"A bearable noise, distant and brief."* Acoustic descriptors such as *Loudness*, *Duration*, *Location*, *Frequency over time* and *Intelligibility* were coded from this type of description. *Loudness* was the most common acoustic descriptor, used with negative (46%), neutral (32%) and positive (22%) evaluations.

Finally, participants sometimes reported what the sounds evoked for them through their *Relevance*, a *Feeling*, a *Moment*, or a *Sensation*. For instance, P08 sometimes appreciated *Indoor speech*: *"It's lovely in the morning; it puts me in a good mood."*

Each free-verbalization could refer to different aspects of a sound, and then be associated with different descriptors. Thus, participants sometimes made some relations between the three types of descriptors (affective, acoustic, evocative), as P04 did: *"Too high-pitched, it stands out from the rest and therefore breaks your focus."* Fig. 5 displays the number of verbalizations where participants used acoustic or evocative descriptors to explain affective ones.

Annoyance is highly related to *Loudness*, *Relevance*

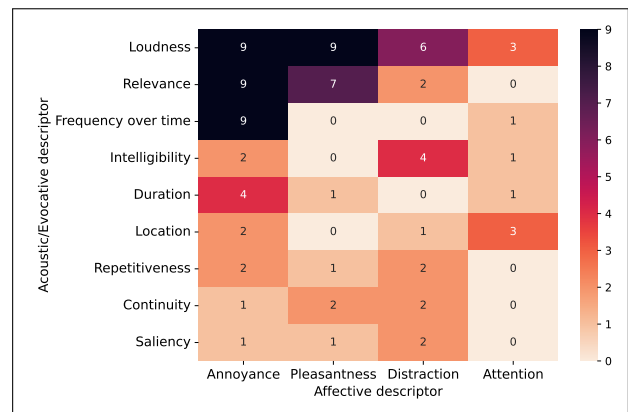


Figure 5: Relations between affective, acoustic and evocative descriptors based on participants' verbalizations.

and *Frequency over time*, suggesting that the context of a sound and how often it occurs play a role in its evaluation. A sound that occurs frequently could be perceived differently. Indeed, P08 described a phone call: *"Very annoying to me, really distracting and happens too often."*, while P10 said about a keyboard: *"These noises sometimes bother me, but they're so ever-present that I've got used to them a bit."*

Pleasantness is mainly related to *Loudness* and *Relevance*, more negatively than positively, as P13 stated: *"This noise is not pleasant in a workspace."*

Distraction is more related to *Loudness* and *Intelligibility* of speech. In fact, participants reported an increase in their distraction as they perceived speech, whether highly intelligible or almost unintelligible. P10 first shared: *"I can't concentrate on my work, and what's worse: I'm listening to everything he says!"*, and then: *"It makes you prick up your ears when the whispers are hard to make out, it breaks your concentration."*

Finally, *Attention* is equally related to *Loudness* and *Location*. P02 had their attention caught: *"It's a bit unsettling when it comes from another workstation, but not unpleasant."*, while P12 was not distracted: *"Very low sound, so you hardly notice it."*

3.4. Coping strategies

In Task 2.b, participants explained what they do to cope with noise when they feel disturbed while working. Three main behaviors were identified: adaptation to the sound environment, isolation, and doing something about the noise source. Different strategies and their reported efficiency are shown in Fig. 6.

Participants tried to adapt to their sound environment at first, by *Ignoring* the noise, *Changing task*, or taking some *Breaks*. Nine participants tried to *ignore* the annoying noise, but this strategy was not efficient when it was catching their attention or when participants were tired, as P12 shared: *"Ignoring it didn't work because the conversations drew attention. However, it only lasted a few minutes."*

Changing task is quite useful, as it enables participants to change their focus or wait until the annoying noise

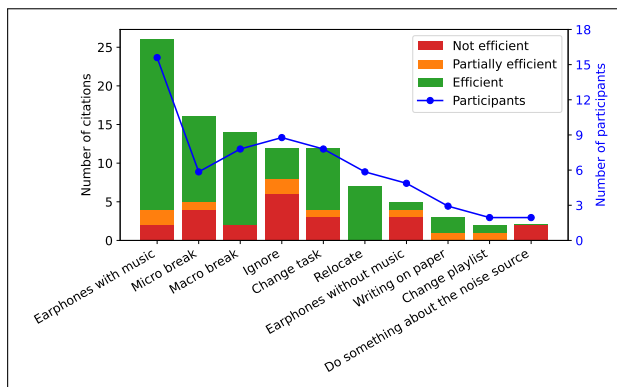


Figure 6: Coping strategies used by participants when they felt disturbed by noise, reported in Task 2.b.

ends, as P12 stated: *"The discussion lasted about ten minutes. I got back to my activities afterwards."*

Participants also take some breaks when noise is too annoying. The distinction made between micro and macro breaks is related to the duration and the location of the break. When participants do *macro breaks*, they leave their workstation to do something in another area. This enables them to rest, wait until the noise is gone, and remotivate, as P05 stated: *"The break at the snack bar made the annoyance pass and remotivated me."* Participants could also simply accept the distraction. P22 explained they do a break by joining a conversation that distracted them: *"Because sometimes trying to focus at all costs can be exhausting. You have to know when to let go so you can refocus better later."* On the contrary, *micro breaks* can be very quick and happen at the workstation. Participants could take a look outside, or spend a few minutes on their mobile phone. As with *changing task*, this strategy is useful for short noise distractions, as P20 shared: *"The break from my phone made me feel better, and I got back to work when they (the conversations) finished."* But sometimes noise is too distracting, as P05 described: *"I've been way too obsessed with these 'crazy' sheets."*

Second, participants could isolate from the noise, by putting on *earphones with or without music*, or *relocating*. *Listening to music through earphones* is the most mentioned strategy, used a total of 26 times by 16 participants. It is generally judged to be effective; as the participants explained, this strategy helps them concentrate, isolates them from the ambient environment by masking noise, and gives some rhythm to their work. P02 stated: *"I couldn't hear the disturbance anymore + there's nothing like music to focus."* *Relocation* is the only strategy that is always efficient. It is less used than the previous ones, probably because it demands more effort, but participants explained it helps them concentrating as they were completely isolated from the noise. Also, participants could use this strategy not to completely isolate, but rather to change their environment. P14 explained: *"A completely different atmosphere. What's more, changing*

seats also helped clear my head."

Finally, participants could *do something about the noise source*, but this strategy was not used very much, as it was rarely possible to tackle the noise directly. P10 was disturbed by phone notification sounds: *"My strategy is purely psychological, because I switch off my notifications thinking the noise is coming from my computer, when in fact it's my coworkers."*

4. Discussion

Sound seems to be an important factor in participants' perception of their workspace. This result is consistent with the literature on employee satisfaction in open-plan offices, which indicates that people are less satisfied with the acoustic environment than they are with other physical environmental factors [11]. However, in our study this result could have been influenced by the fact that participants were aware of the subject of the study, which may have led them to talk more about the sound aspect of their offices.

Participant responses to Task 2.a comprised the main part of the diary. First, they named sounds they could hear while working, and judged them with an overall feeling. As participants sometimes judged a whole acoustical context instead of specific sound sources, no direct link could be made between the general feeling and the different reported sound sources. Nevertheless, indoor speech was the sound source reported most often, and was negatively rated for 45% of the citations, as expected from the literature [12]. Silence was also identified as a source by participants, who always rated it positively. This result shows that even in quiet workspaces, silence is preferred to any sound sources. Participant feelings about silence will be further investigated during the interviews analysis, to see how effective it is to use additive approaches instead of reducing the soundscape's level.

Second, participants explained their general feeling in their own words, and descriptors were extracted from their verbalizations. The affective identified descriptors can be related to the hedonic description introduced by Duroyon [13], while acoustic and evocative descriptors correspond to the acoustic and semantic descriptions identified by Carron [14]. Participants mainly expressed a feeling by using affective descriptors, which could sometimes be explained by acoustic or evocative ones. In such cases, *Loudness* was the principal factor responsible for *Annoyance*, *Pleasantness*, and *Distraction*, which confirms previous results from the literature [1]. Other factors such as *Relevance* and *Frequency over time* deserve consideration, as they also impacted participants' feelings.

After talking about sounds, participants reported their behaviors to cope with noise, which could be divided into three main categories: adapting to the soundscape, isolating from it, and doing something about the noise source. Notably, listening to music through earphones was the strategy reported most often, as it allows the participant to mask disturbing noise without interrupting their work. While some participants

said that music motivated them, others explained they don't really like wearing earphones, but they do it because they are efficient at masking noise. This difference in preferences should be further investigated, and augmented approaches that transform the soundscape could help to conceal unwanted sounds and allow people to focus without having to use earphones. Finally, these results should be interpreted in light of certain limitations of the study. First, as the diary was completed over a two-week period, the results obtained did not capture the participants' year-round experience. Nevertheless, participants stated during the interviews that the reported data were fairly representative of the usual soundscape in the various workspaces. Second, while the variety of investigated workspaces helped to distinguish both shared experiences among all participants and more specific experiences related to a particular workspace, a higher number of participants should be considered to further examine the variety of users' perceptions between different types of open-plan offices. Also, different treatment strategies should be considered to enhance the soundscapes of the investigated workspaces, as only one of them had their acoustics treated. Notably, participants from the treated workspace identified speech and mouth sounds as annoying, even if at low level. Such results support the use of an augmented approach in this particular workspace.

5. Conclusion

A diary-interview methodology was used to collect insights about people's perception of their workspace and its soundscape. Responses from the diaries revealed indoor speech to be the most frequently mentioned sound source, and participants mainly expressed their feeling about sounds in terms of annoyance. This could be explained partly by the loudness, the frequency over time and the relevance of the sound sources. While these findings correspond with the literature, they point out the difference in participant behavior between isolation and adaptation. Adaptation supports augmented approaches that aim at positively transforming the soundscape to improve its quality. The outcomes of this study will be consolidated with the interviews analysis to better understand people's sound perception at work, and will then inform the design and the implementation of adaptive signals to conceal open-plan offices soundscapes.

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References

- [1] M. Pierrette, E. Parizet, P. Chevret, and J. Chatillon, "Noise effect on comfort in open-space offices: Development of an assessment questionnaire," *Ergonomics*, vol. 58, 2015.
- [2] P. Chevret, "Environnement sonore en bureaux ouverts : Evaluation de la gêne et démarche d'amélioration," INRS, Tech. Rep., 2026. [Online]. Available: <https://www.inrs.fr/media.html?refINRS=ED%206402>.
- [3] L. Bergefurt, R. Appel-Meulenbroek, and T. Arntze, "Level-adaptive sound masking in the open-plan office: How does it influence noise distraction, coping, and mental health?" *Applied Acoustics*, vol. 217, p. 109 845, 2024.
- [4] A. Solorio, L. M. Alonso-Valerdi, and D. I. Ibarra-Zarate, "Neurophysiological and perceptual insights into the benefits of natural sound masking in open-plan offices," *Applied Acoustics*, vol. 248, 2026.
- [5] C. Boukhemia, N. Misdariis, and M. Lagrange, "Characterizing new modalities of shared offices: A diary-interview methodology to inform audio augmented reality approaches," in *11th Convention of the EAA*, vol. 2, 2025.
- [6] D. H. Zimmerman and D. L. Wieder, "The Diary: Diary-Interview Method," *Urban Life*, vol. 5, 1977.
- [7] A. Brailas, E. Tragou, and K. Papachristopoulos, "Introduction to Qualitative Data Analysis and Coding with QualCoder," *American Journal of Qualitative Research*, vol. 7, 2023.
- [8] V. Braun and V. Clarke, "Using thematic analysis in psychology," *Qualitative Research in Psychology*, vol. 3, 2006.
- [9] W. Gaver, "What in the world do we hear?: An ecological approach to auditory event perception," *Ecological Psychology*, vol. 5, 1993.
- [10] V. Acun, "Investigating the effect of indoor soundscaping towards employees' mood and perception in open-plan offices," M.S. thesis, İhsan Doğramacı Bilkent University, 2015.
- [11] N. Perrin Jegen and P. Chevret, "Effect of noise on comfort in open-plan offices: Application of an assessment questionnaire," *Ergonomics*, vol. 60, 2017.
- [12] P. E. Braat-Eggen, A. Van Heijst, M. Hornikx, and A. Kohlrausch, "Noise disturbance in open-plan study environments: A field study on noise sources, student tasks and room acoustic parameters," *Ergonomics*, vol. 60, 2017.
- [13] M. Duroyon, "De l'étude du confort sonore de l'habitable du véhicule électrique à son amélioration par l'acoustique augmentée," Ph.D. dissertation, 2025.
- [14] M. Carron, "Méthodes et outils pour définir et véhiculer une identité sonore : Application au design sonore identitaire de la marque SNCF," Ph.D. dissertation, Pierre et Marie Curie, 2016.

