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Editorial: Acoustics in the Built Environment: A Challenge for Improving the Quality of Life

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Editorial on the Research Topic

Acoustics in the Built Environment: A Challenge for Improving the Quality of Life

The acoustics of the environment in which we live influences our health, comfort, performance, and well-being. In this Research Topic, it is showcased that quality of life can be changed and improved by optimizing the acoustics of the built environment. This is done by addressing the complexity of the interactions between the occupants and the sonic environment. A variety of indoor and outdoor settings, in which either communication or perception are targeted, have been taken into consideration by the contributions in this special issue. In particular, the collected papers focused on four critical aspects: effects of noise in learning environments, communication in noise and reverberation, soundscape optimization for outdoor and indoor applications, and development of perception-based criteria in acoustical design.

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EFFECTS OF SOUNDSCAPE IN LEARNING ENVIRONMENTS

The sonic environment of learning spaces impacts students' perception and learning. Young children are especially vulnerable to the effects of background noise and reverberation due to their still immature cognitive and linguistic skills. Furthermore, task performance and effort of older students in complex academic tasks might be negatively affected by unfavorable classroom acoustics.

Loh et al. investigated the sonic environment of classrooms and playrooms with a campaign of measurements in both occupied and unoccupied conditions. Importantly, the authors point out the necessity to use appropriate transducers in measurements with children (i.e., children head-and-torso simulator) and to consider complementing traditional acoustic parameters with psychoacoustic ones. The link between objective measurements and children's perceptual evaluation was explored by Persson Waye and Karlberg for preschool-age children. It was found that, despite small changes in background noise levels and reverberation, the improvement in the acoustic conditions was clearly perceived by the children. In particular, favorable acoustic conditions allowed for a significant reduction in the perception of sounds along with a reduction in children's reaction to them. Brill and Wang surveyed the acoustic conditions of occupied classrooms in primary and secondary schools and analyzed their relationship with standardized achievement test results in the math and reading areas. Daily non-speech levels were found to be negatively correlated with math test scores whereas reading achievement was not correlated with any of the acoustic parameters included in the survey.

Regarding older students, Braat-Eggen et al. investigated how changes in the sound environment (i.e., reverberation time or number of talkers) affect complex cognitive tasks. Changes in the sound environment negatively impacted only the performance in a logical reasoning task whereas a significant effect of the sound scenarios was found on self-estimated performance and perceived disturbance for reading comprehension with text memory and mental arithmetic. It is evident that the sonic environment affects not only task performance but also cognitive processing, as estimated by self-reports of the listeners. Visentin and Prodi used self-reports for measuring changes in school-aged children's perceived effort while working in a noisy classroom. It was found that self-ratings were sensitive to the spectro-temporal characteristics of the background noise, but only for a speech perception task, emphasizing the need for further research on a topic which to date is still under-investigated.

EFFECTS OF NOISE AND REVERBERATION ON THE SPEECH COMMUNICATION PROCESS

The speech communication process accounts for premises related to the talker, to the listener, and to the environmental path that links them. As far as the talker perspective is concerned, Sierra-Polanco et al. investigated the effects of aural feedback, reverberation, and noise on speech production. They found that an increase in gain causes a decrease in the voice sound pressure level and a consequent increase in self-reported vocal comfort. Substantial variations in speech level, instead, were not found for reverberation times that varied from 0.07 to 1.90 s at mid frequencies. Considering the listener's perspective, Warzybok et al. investigate the interplay of bottom-up and top-down resources in noise and reverberation. They found that under poor room acoustic conditions, being familiar with the speech material allows for higher speech intelligibility. Thus, the work highlights the influence of higher-level lexical-semantic cues in speech recognition and underscores the limits of conventional tools for assessment even in the common scenario of everyday communication. Taken together, these contributions stress the need to blend the acoustical needs of the listeners with those of the talker to make a step-forward in design practice.

THE ROLE OF SOUNDSCAPE ON THE PERCEPTION OF PUBLIC ENVIRONMENTS

Soundscape, defined by ISO as an acoustic environment as perceived or experienced and/or understood by a person or people, in context, has attracted much attention in both research and practice. Qi et al. conducted an on-site questionnaire investigation at two artificial lakes in Xi'an, China, to explore which blue space characteristics would contribute to a better soundscape and visiting experience. It was found that the eight Perceived Sensory Dimensions of artificial lake spaces, except for social, were positively correlated with soundscape satisfaction, overall satisfaction, soundscape restorativeness, and overall restorativeness. Indoor soundscaping is also important for soundscape studies. Steffens et al. carried out field studies in 12 restaurants in Berlin, investigating whether sound level, reverberation time, and soundscape pleasantness can predict factors associated with overall restaurant quality. It was found that both $L_{A,eq,15}$ and T20 had a significant influence on soundscape pleasantness and eventfulness, and LA,eq, 15 as well as soundscape pleasantness were significant predictors of overall restaurant quality. It is also noted that technologies to control sound field are important too for soundscape creation, where a challenge is to achieve adequate acoustics while maintaining the aesthetics of the space. Cucharero et al. developed a biofiber-based acoustic coating as a feasible solution to improve acoustic environments while preserving the aesthetics of spaces.

SOUND PERCEPTION AS A DRIVER FOR INNOVATIVE ENVIRONMENTAL DESIGN TO FACE THE LATEST SOCIETAL CHALLENGES

The technological evolution of different aspects of our life has posed several challenges to our perception of the everyday environment. Soeta and Onogawa highlighted that although the sound produced by air conditioners has been limited to a comparatively low level, some people may still perceive discomfort. They built a predictive model for the subjective response to the air conditioner sound's quality and levels. A deep knowledge on these types of models could help to assess our perception even in exceptional working conditions. Puglisi et al. showed that perceived noise during the COVID-19 pandemic remote working had a significant effect on working activity and performance. Among the noise sources investigated, 25% of a total of 1,934 of workers recognized the noise generated by people (e.g., talking, moving, calling, listening to music) as the main source of disturbance. A perceptual test may be used to further develop our everyday environment virtualization. Llorca-Bofi and Vorländer highlighted the gap between building simulation and physically based material models. They provided targeted modeling strategies for architects, in both indoor and outdoor demonstrations, for auditory-visual research.

To sum up, the 13 articles in the special issue demonstrate that a novel approach to the acoustics of built environments can be pursued. It is based on the full integration of physical, perceptual, and cognitive features that are elicited in listeners and talkers when interacting with the sonic environment. This framework is promising and can be exploited to improve our knowledge on the impact of sound on the users' activities. In addition, thanks to such novel approaches, the efficacy of the available control strategies can be enhanced, and new ones can be developed too. Together, knowledge and technologies will foster a more enjoyable user experience and improve their quality of life.

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All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

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