frontiers in Acoustics

TYPE Editorial
PUBLISHED 16 February 2026
DOI 10.3389/facou.2026.1802446

OPEN ACCESS

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RECEIVED 02 February 2026
ACCEPTED 04 February 2026
PUBLISHED 16 February 2026

CITATION
Torija AJ, Krishnamurthy S and Merino-Martinez R (2026) Editorial: perception-driven acoustic engineering. *Front. Acoust.* 4:1802446.
doi: 10.3389/facou.2026.1802446

Editorial: perception-driven acoustic engineering

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KEYWORDS
acoustics, advanced air mobility (AAM), electric mobility, engineering design, perception-driven engineering, psychoacoustics

Editorial on the Research Topic
Perception-driven acoustic engineering

The rapid expansion of electric mobility, spanning electrified road vehicles and emerging forms of advanced air mobility (AAM), is driving a profound shift in the sounds that populate everyday environments. As propulsion architectures change, so do acoustic signatures and conventional methods to describe them. In this context, "*perception-driven acoustic engineering*" is increasingly necessary for the design and operation of new transportation systems. Accordingly, the present Research Topic was established to highlight methods and evidence that embed human response into engineering workflows, from measurement and modelling to evaluation and policy-relevant decision-making.

Since its introduction by Davies (2007), this approach has received significant attention, notably in aircraft design Rizzi (2016). As a structured methodology, a perception-driven engineering framework integrates sound acquisition, sound evaluation, and design implementation, explicitly quantifying acoustic and human factors alongside other key engineering parameters to inform robust and optimised final designs.

A central theme across the contributions is the recognition that human response is shaped by a combination of acoustic and non-acoustic influences, requiring engineering methods that explicitly account for these interacting factors. This is illustrated clearly by Woodcock et al., who examine annoyance responses to the sound of a medical-delivery drone under varying operational and contextual conditions. The authors show that annoyance depends not only on physical factors, such as listener–drone distance and ambient soundscape (Lotinga et al., 2025a; Green et al., 2025), but also on contextual information (Krishnamurthy et al., 2023), including whether listeners are told the drone is being used for medical deliveries. Annoyance decreased with increasing distance and was higher in quieter environments (Lotinga et al., 2025b), while providing medical-use context significantly reduced annoyance. These results highlight the importance of community engagement, as perceived purpose influences noise response alongside acoustic mitigation. A key conclusion of Woodcock et al. is therefore that drone and AAM integration must be socio-acoustically informed, combining acoustic design and operational planning with communication strategies that address how communities interpret new sounds.

An important challenge is how we measure and model perception in ways that are usable in design cycles. Münder et al. argue that evaluating electric vehicle acoustic experience must account for the time-varying nature of the associated acoustic signals. To capture this temporal variation, they use the Continuous Evaluation Procedure (CEP) to obtain moment-by-moment judgments while participants listen to accelerating electric vehicles in an immersive simulator. Their results show that CEP uncovers time-dependent patterns in quality and annoyance that are missed by conventional single-value ratings, and they recommend its systematic adoption for transient acoustic events. By treating acceleration as a perceptual episode with internal structure, Münder et al. offer a practical link between psychoacoustics and engineering validation, enabling designers to identify and control undesirable perceptual phases in an operational sequence.

Benghanem et al. address the need for efficient prediction of perceptual attributes. They develop objective models for sensory attributes and desire-to-buy judgments of recreational vehicles using parsimonious multiple linear regression methods (Lasso (Tibshirani, 1996) and Elastic Net (Zou and Hastie, 2005)). These models are trained on combinations of standard engineering and psychoacoustic metrics together with descriptors derived from Music Information Retrieval (MIR) feature extraction. Their analysis shows that compact linear models can reliably represent the full set of perceptual attributes, including desire-to-buy, while relying on only a small number of physical and psychophysical predictors. Importantly, this work reinforces a message aligned with Industry 5.0 goals that perception-driven design can link perceptual targets such as softness, aggressiveness, and perceived power to a manageable set of metrics, enabling actionable guidance for engineering design.

The Research Topic also shows that perception-driven engineering must operate within wider governance, health, and equity contexts, particularly as new aerial mobility vehicles introduce novel noise exposure patterns with implications for public health and fairness. Lavia et al. address this need by proposing a transdisciplinary Sound, Noise and Health Conceptual Framework aimed at supporting fair and equitable dispersion of aircraft operations. By embedding dispersion and impact management within a structure that integrates stakeholder engagement and non-acoustic moderators, Lavia et al. show how perception-driven acoustics can support policy decisions, shifting the focus from narrow sound level-based optimisation toward broader considerations of health, equity, and contextual response. This contribution is especially important for future AAM systems, where routing, scheduling, and operational concepts may evolve more quickly than community responses can be measured.

Looking ahead, the continued expansion of electric mobility and autonomous systems will further increase the complexity of future soundscapes. The contributions in this Research Topic point toward an emerging consensus: progress will rely on simplified and interpretable models that accurately link physical design parameters to perceived sound quality, advances in auralisation and psychoacoustic modelling, clearer definitions of key performance indicators to guide optimisation, and evaluation methods that integrate contextual and societal factors. This progress will ensure that acoustic design supports not only technical performance but also human experience and community wellbeing.

Author contributions

AT: Writing – original draft, Conceptualization, Writing – review and editing. SK: Writing – review and editing. RM-M: Writing – review and editing.

Funding

The author(s) declared that financial support was received for this work and/or its publication. Antonio J Torija would like to acknowledge the funding provided by UK Engineering and Physical Sciences Research Council for the DroneNoise project (EP/V031848/1), Innovate UK for the InCEPTion project (ref. 73692), and Horizon Europe and the UK Research and Innovation (UKRI) under the UK government's Horizon Europe for the ImAFUSA (No. 10080939) and REFMAP (No. 10061935) projects.

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The authors AT, SK, RM-M declared that they were an editorial board member of Frontiers at the time of submission. This had no impact on the peer review process and the final decision.

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