Title:
Stabilising Sound: A Perceptual Audio Framework for Balance Support Inspired by Vestibular Stimulation

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10.5281/zenodo.15546429

Date:
29 May 2025

Abstract

This note outlines a proposal for a perceptual audio system that may help stabilise balance and reduce fall risk using low-frequency sound cues delivered through everyday listening devices. It is inspired by recent findings showing that 100 Hz auditory stimulation can reduce motion sickness by activating the otolithic organs of the inner ear. The approach discussed here is non-invasive, low-risk, and suitable for wide deployment. It could complement existing hearing aids, wearables, or public address systems in transport and care environments. This framework is not a commercial product, but an openly shared concept intended to encourage discussion and collaborative refinement.

Background

A recent study by researchers at Nagoya University's Graduate School of Medicine demonstrated that exposure to a 100 Hz sound significantly reduced motion sickness symptoms (Kagawa et al., 2024). The mechanism involves targeted stimulation of the vestibular system's otolithic organs, which detect linear acceleration and gravitational shifts. This raises the possibility that low-frequency auditory cues may offer practical benefits in supporting balance, not only in transport contexts but more broadly in healthcare, accessibility, and personal wellbeing.

Proposal

Building on these findings, I propose an adaptive audio system that activates only when signs of instability are detected, delivering a tailored low-frequency pulse to help the brain correct and regain postural control. Rather than broadcasting a constant signal, the system would act momentarily and perceptually—much like a gentle nudge or grounding tap. This may aid in interrupting loss of balance in people with neurological, vestibular, or age-related impairments, without distracting or fatiguing the listener.

Applications

Potential use cases include:

- Integration into hearing aids or bone conduction devices
- Use in home audio systems to assist older adults
- Mobile deployment through smartphones or sleep speakers
- Embedded support in walking aids, wheelchairs, or transport seating

The goal is not medical intervention, but perceptual support that improves confidence and environmental navigation. Fall prevention remains a major public health goal: over 160 million people worldwide experience balance challenges, and falls are a leading cause of injury and mortality among older adults.

Design Considerations

The system could employ:

- Passive calibration using microphone input to infer posture or movement
- Context-aware activation based on gait, proximity, or sudden shifts
- Age-based EQ shaping (e.g., ISO 7029)
- No biometric registration, cloud dependency, or invasive sensing

Auditory feedback would be brief, low-level, and delivered in a way that does not compete with foreground tasks such as speech, navigation, or media.

Ethical Dimensions

The system should respect privacy, operate transparently, and be clearly positioned as perceptual—not therapeutic—support. It must also be designed to avoid over-reliance or habituation, offering assistance only when appropriate and in accordance with user preferences.

Future Directions

The concept may benefit from reinforcement learning or participatory design to shape the cueing system around real-world needs. Broader studies are encouraged, particularly in collaboration with those working in accessibility, care technologies, and perceptual computing. This proposal is one of several ongoing efforts to explore how sound can be harnessed not only for communication or immersion, but to support physical and emotional wellbeing.

Reference

Kagawa, T., et al. (2024). *Alleviating symptoms of motion sickness with short-term sound stimulation: A unique 100 Hz auditory cue targeting the otolithic organs*. Environmental Health and Preventive Medicine. https://doi.org/10.1265/ehpm.24.101

Keywords

Perceptual Audio, Balance Support, Vestibular Stimulation, Accessibility, Low-Frequency Sound, Inclusive Design, Ageing, Hearing Health