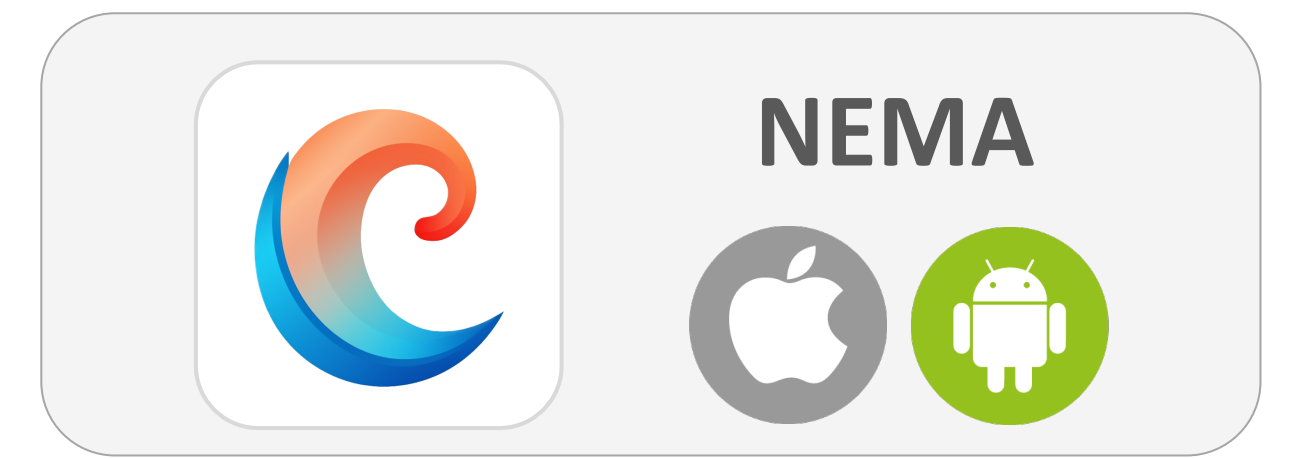


# NEMA: An Ecologically Valid Tool for Assessing Hearing Devices, Advanced Algorithms, and Communication in Diverse Listening Environments

Nicky Chong-White, Arun Sebastian, Jorge Mejia  
National Acoustic Laboratories, Sydney, Australia



## Abstract

- **Ecological Momentary Assessment (EMA)** is a valuable research method for assessing the effectiveness of hearing devices and communication in real-world scenarios and addresses the limitations of objective metrics and laboratory evaluations.
- Our NEMA smartphone app collects repeated self-reports and relevant acoustic features in users' natural environments.
- We highlight NEMA's design features and extended capabilities which support efficient data gathering, and present how NEMA has provided real-world insights and evidence of user benefits in hearing research, including a clinical trial.

## Introduction

- The rapid evolution of hearing assistive technology necessitates a robust and ecologically valid evaluation process.
- Traditional assessment methods, such as retrospective surveys and controlled laboratory tests, suffer from recall bias or fail to capture varied, dynamic real-world listening conditions. They also overlook factors like fatigue, stress, and visual or contextual cues, which can influence communication.
- Ecological Momentary Assessment (EMA) addresses these limitations. By collecting data in users' natural environments during, or shortly after, a listening situation, EMA provides invaluable real-world evidence of an individual's experience and the effectiveness of given interventions.
- The NEMA app, developed at NAL, has been used in over 10 hearing research studies, and has proven effective in understanding the behaviour of people with hearing difficulties across diverse listening situations.

## Key Features of NEMA

NEMA is a customisable, remotely distributable iOS and Android app that enables efficient data collection in daily life. It captures "snapshots" of real-world experiences.

- **Self report survey:** Customisable survey to collect data on speech understanding, listening effort, emotions, or preferences for specific device settings.
- **Objective acoustic features:** These provide additional context. Features include sound level, spectral flatness, and spectral-temporal envelope modulation. For privacy, no audio is stored.
- **Real-time data analysis:** Data transfer to the cloud allows researchers to monitor data as it collected.
- **Data dashboard:** A secure web-based dashboard and data handling tools help ensure participant compliance and error-free data collection and analyse using advanced methods for immediate insights.

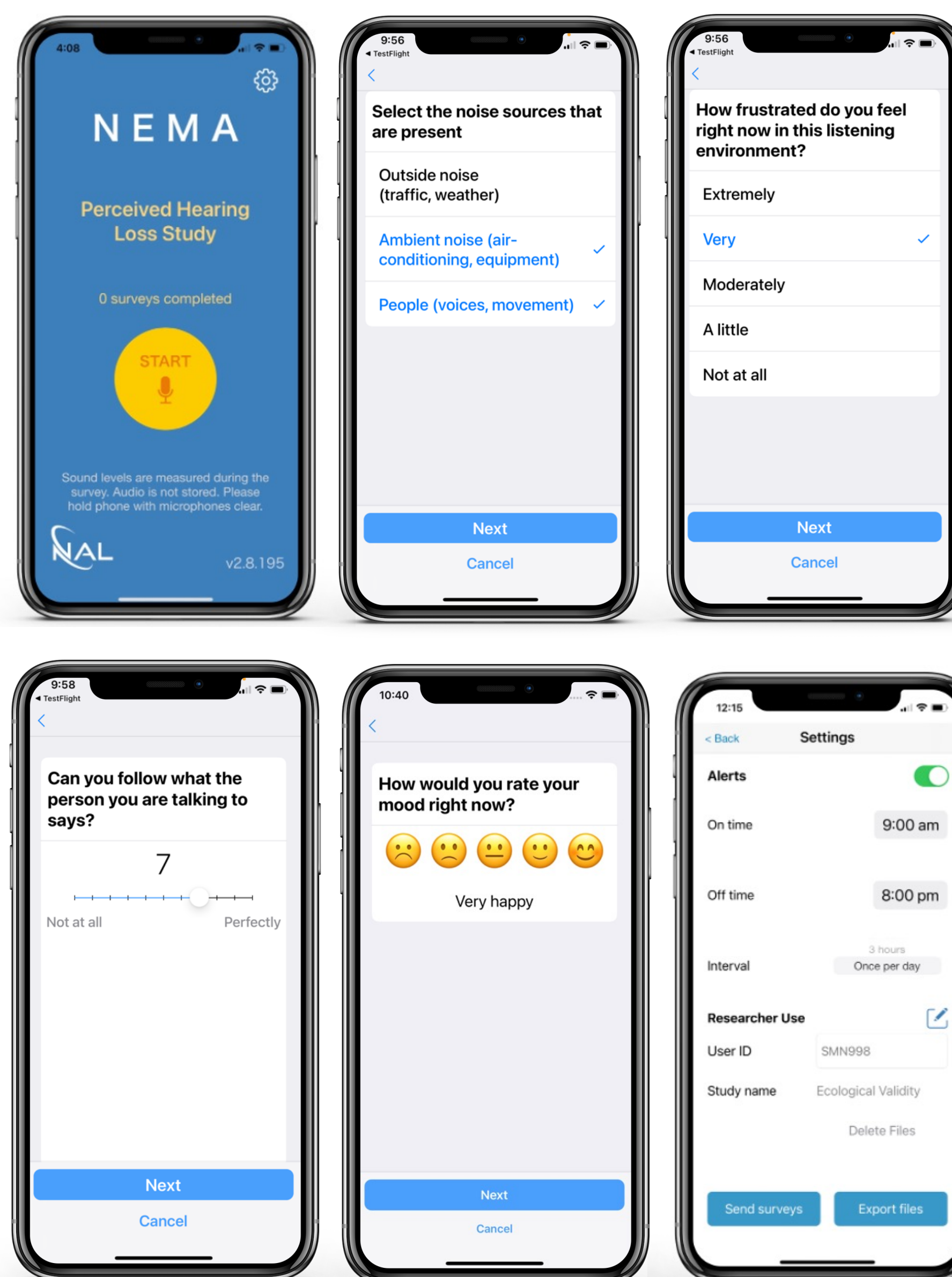


Figure 1: NEMA app screenshots.

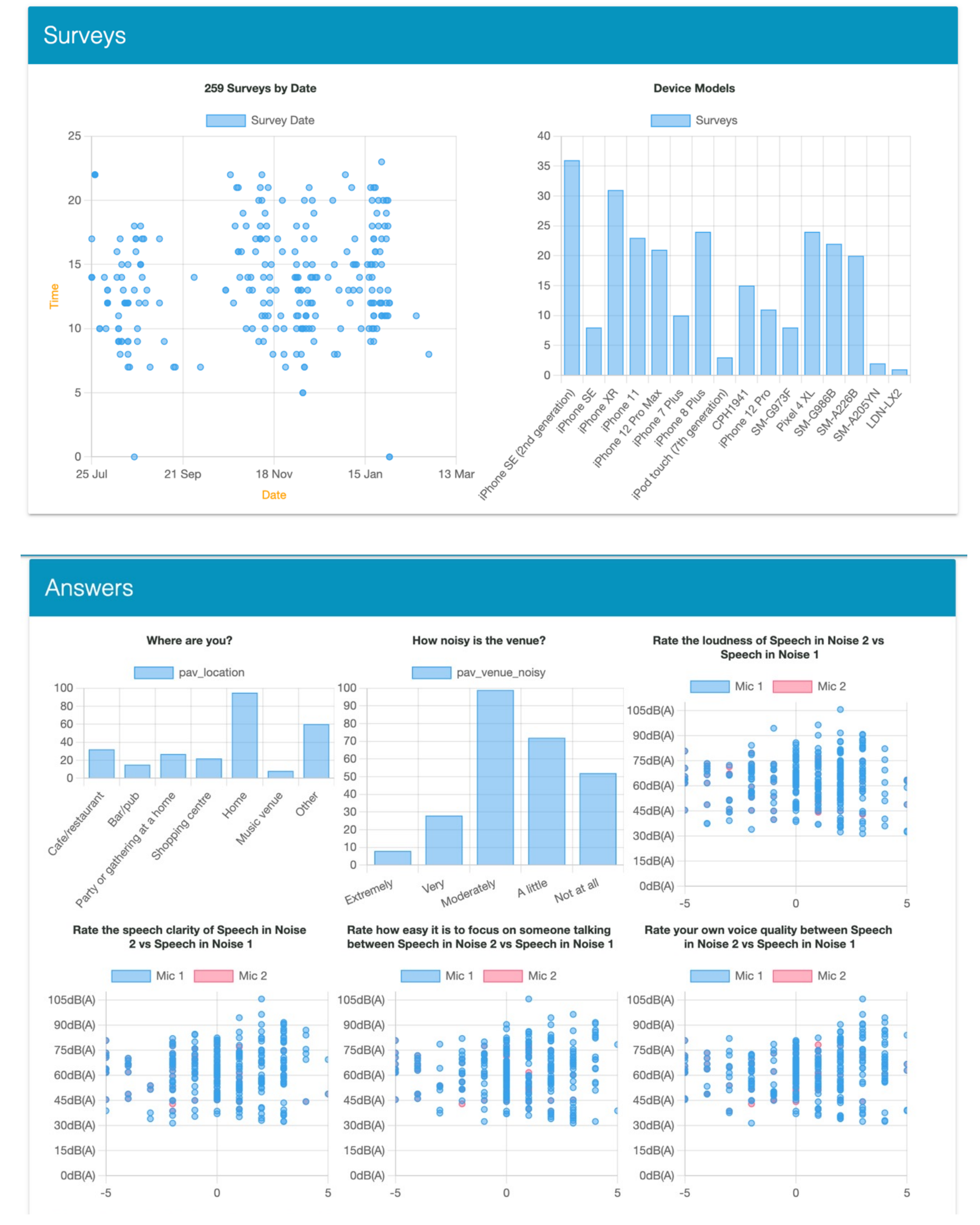


Figure 2: Cloud-based data management

## Case Study: Nuheara Hearing Aids

The Nuheara clinical trial investigated the real-world effectiveness of Nuheara HP Hearing PRO self-fitting hearing aids.

- 43 adults with varying degrees of hearing loss
- 2–4-week field trial, 772 surveys completed
- 30% improvement in speech understanding in noisy places when *Focus* (directional processing) was activated.
- Significant improvements in ease of listening, reduced annoyance of noise and background sounds, and an overall preference for *Focus*.
- Directional processing improved understanding at moderate noise levels, but improvement decreased at extreme high noise levels.
- *Focus* was most effective in environments with background noise of 80-90 dBA.

Real-world insights from NEMA were instrumental in supporting clinical findings to obtain the first FDA clearance for a self-fitting, over-the-counter hearing aid.

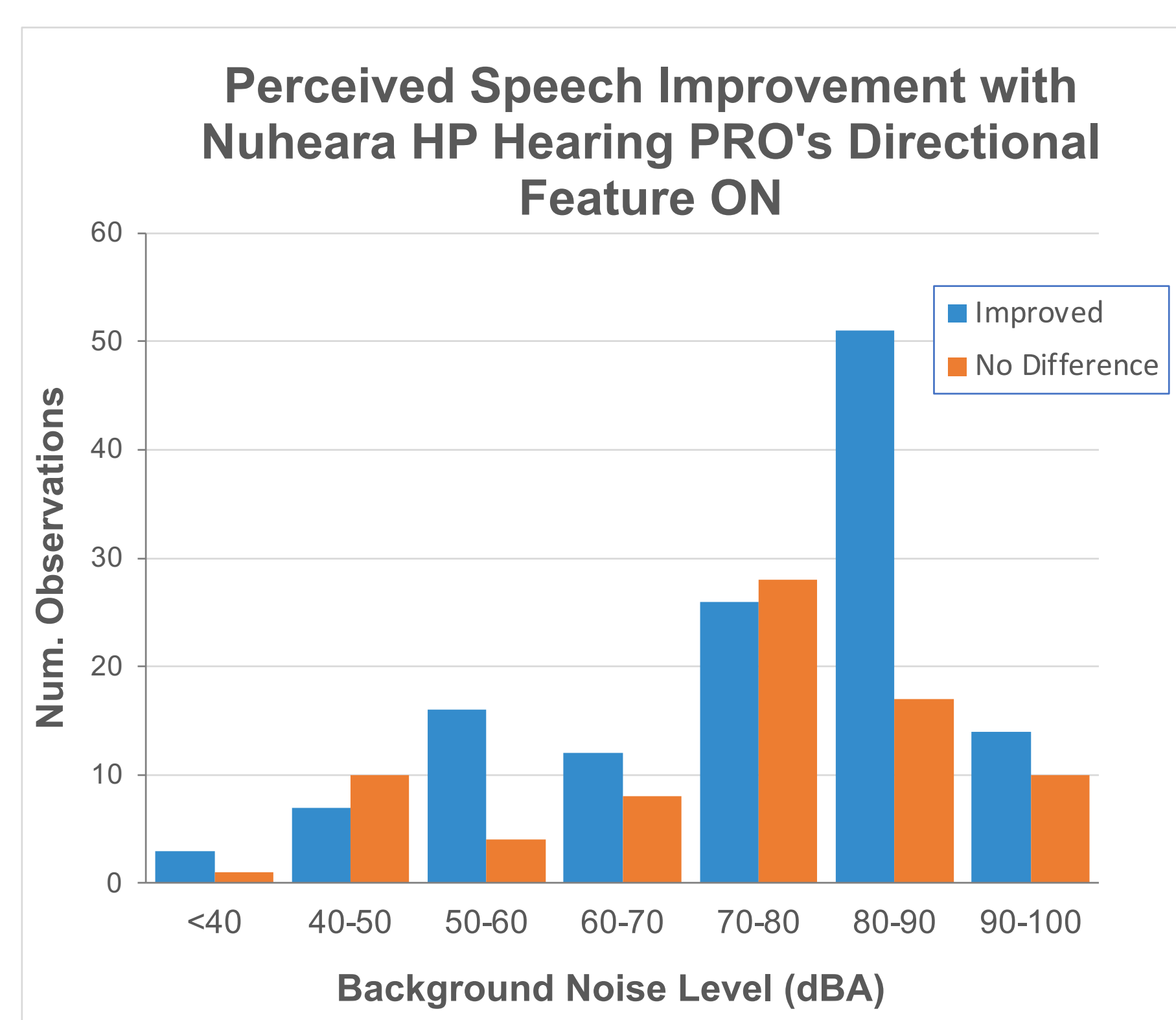


Figure 3: Effectiveness of directional processing in various background noise levels (NEMA ratings)

## Conclusion

- NEMA addresses limitations of traditional hearing device assessments by providing real-world insights.
- Integration of ecologically valid measures into the analysis enables researchers to better understand the impact of new technologies on users' communication and listening experiences.
- NEMA emphasizes the importance of real-world evidence in enriching research findings and providing a comprehensive assessment of hearing technologies.

## References

- G. Keidser, et al., "The quest for ecological validity in hearing science: What it is, why it matters, and how to advance it," *Ear Hear*, vol. 41, Suppl 1, pp. 5S–19S, 2020.
- I. Holube, P. von Gablenz, and J. Bitzer. (2020). "Ecological momentary assessment in hearing research: Current state, challenges, and future directions," *Ear and Hearing*, vol. 41, Suppl 1, pp. 79S–90S, 2020
- B. Timmer, L. Hickson, and S. Launer. "The use of ecological momentary assessment in hearing research and future clinical applications," *Hearing Research*, vol. 369: pp. 24–28, 2018.

