

From the Lab to the Clinic: Using fNIRS to Accelerate Early Intervention for Infants with Hearing Loss

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Poster T135

Our goal is to improve language

Key questions in the hearing care pathway need early answers

- Are hearing aids needed?
- Are hearing aids optimally programmed?
- Would a cochlear implant be better?

What evidence is needed to answer these questions?

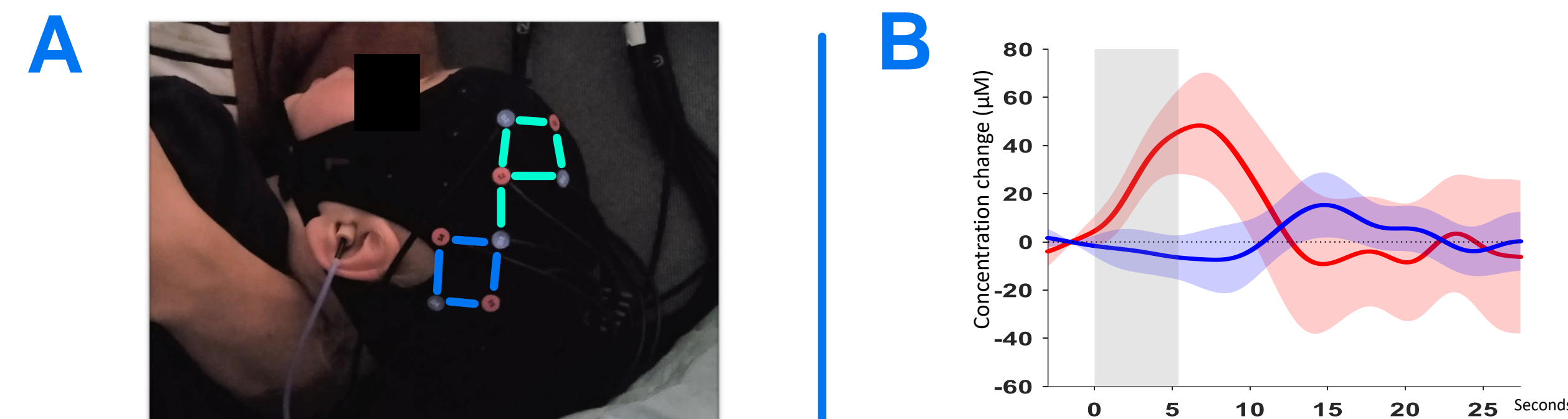
- Accurate measures of hearing acuity in all babies including those with auditory neuropathy
- A clinically feasible measure of speech sound discrimination - currently non-existent in infants

Get the answers early to optimise intervention

- in the first months of life, when behavioural testing is unreliable



fNIRS – the EarGenie technology

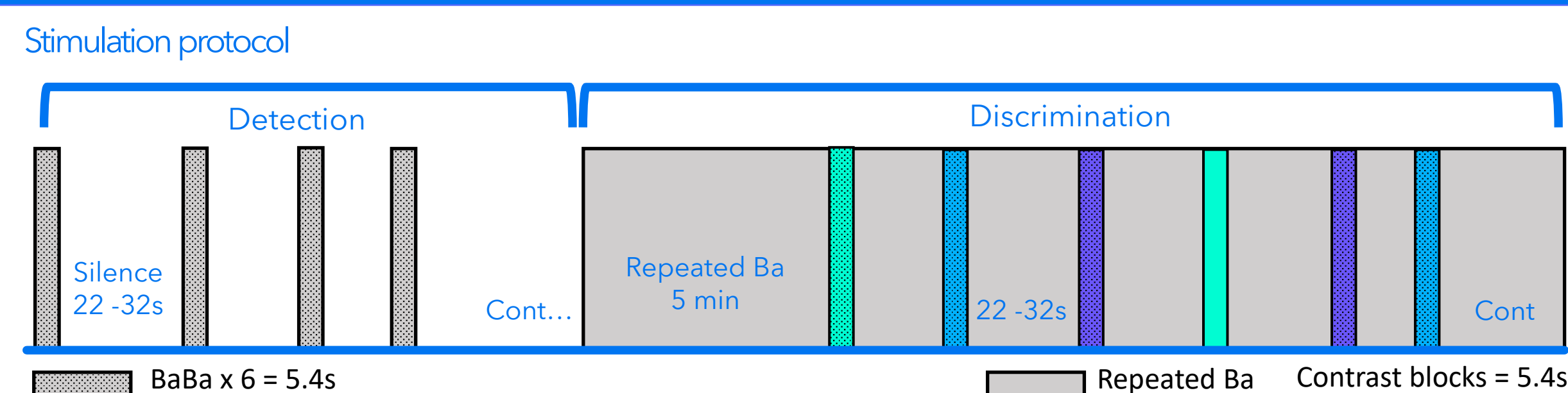


Panel A. Emitters (red) & detectors (blue) of near infra-red light mounted in a research cap showing the left hemisphere montage. Channels making up the left temporal (blue) and prefrontal (green) regions of interest (ROIs) are shown. There is an equivalent right montage.

Panel B. Typical haemodynamic response recorded in a single baby showing changes in oxygenated (red) and deoxygenated (blue) haemoglobin levels following speech sound stimulation (grey shading).

EarGenie Speech Module

measures detection and discrimination of speech at different levels



Presentation • Tubeophone or speaker • Right or left ear • Aided or unaided
Pre-processing and Data Analysis

- Convert to optical density and hemodynamic changes. • Correct motion artifacts using Temporal Derivative Distribution Repair function. • Bandpass Filter between 0.01 – 0.25 Hz. • Discard channels with Scalp Coupling Index <0.8
- Epoch data -3 to 27 s re stimulus onset • Baseline correct to the average of -3 to 0 s.

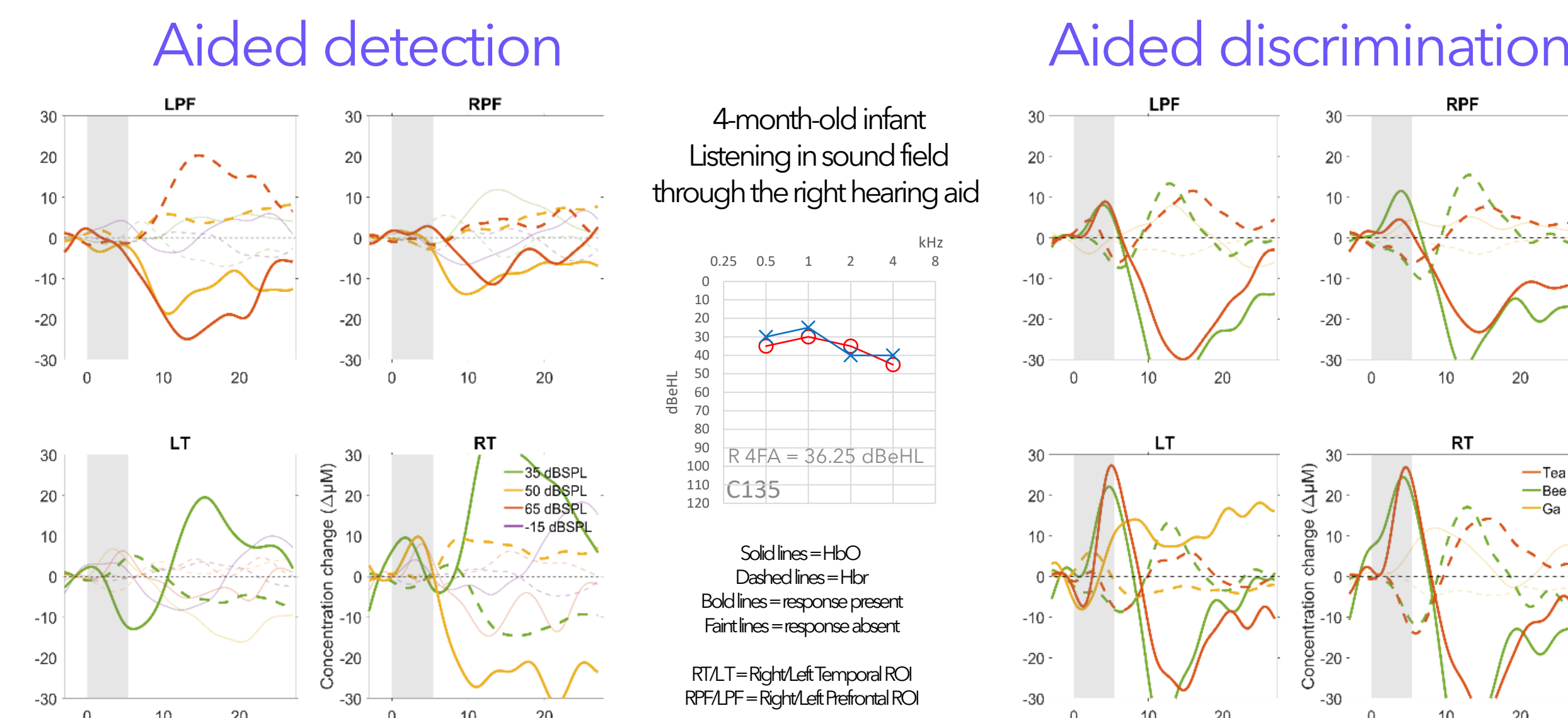
- Assess individual responses in regions of interest (ROI) using EarGenie custom algorithm with >90% accuracy (see Poster S138).
- Control condition (-15 dB SPL stimuli or silence period) to assess probability of false positive responses.

Acknowledgements

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Infant with mild/mod hearing loss

Is their hearing aid well programmed and allowing speech discrimination?



Detection of "Ba" significant responses:

- at all levels within 3-6 trials
- No responses to control level of -15 dB SPL

• **Infant is hearing low, mid and average level speech.**

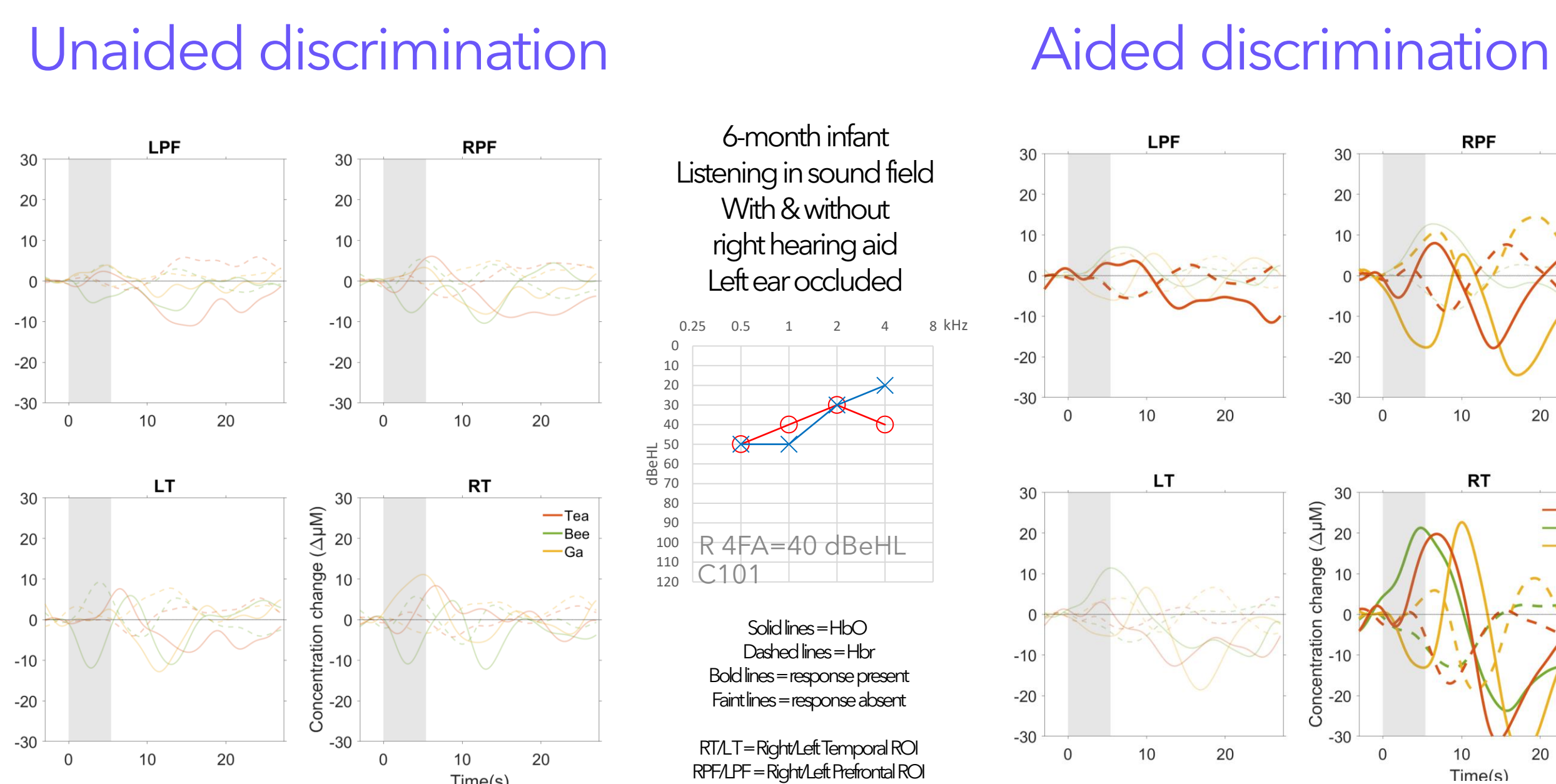
Discrimination at 65 dB SPL

- Strong responses in every ROI for "Ba" vs "Tea" & "Ba" vs "Bee" after 3-6 trials.
- Significant response to "Ba" vs "Ga" in LT only

• **Infant's hearing aid is allowing speech discrimination for all speech contrasts. The response to "Ba" vs "Ga" was weaker.**

Infant with mild hearing loss

What difference does aiding make to speech discrimination?



Unaided at 50 dB SPL:

- Absent responses for all speech contrasts in all ROIs after 10 trials.

• **Infant does not show discrimination for unamplified mid-level speech.**

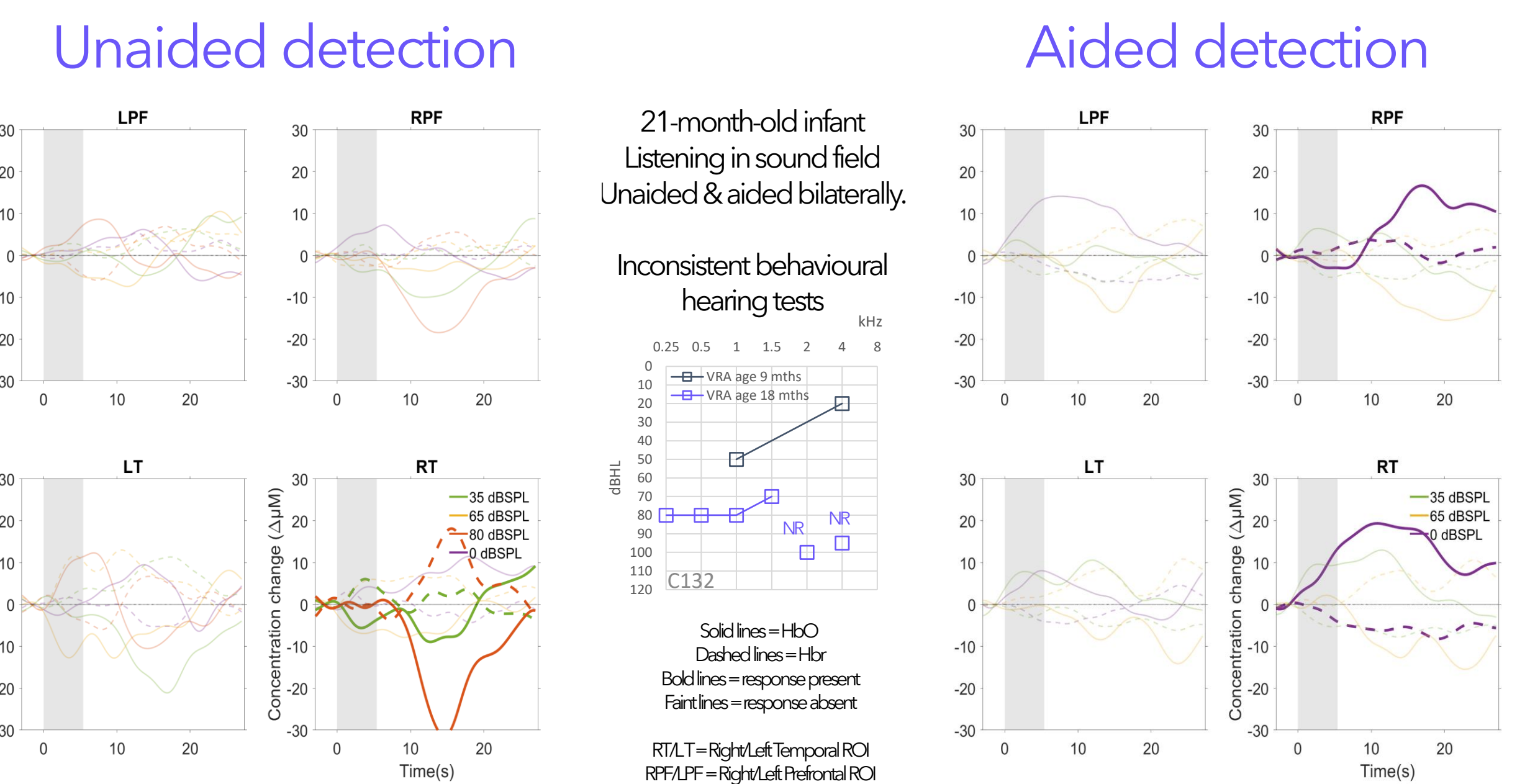
Aided at 50 dB SPL significant responses:

- "Ba" vs "Tea" in all ROIs except LT within 4-8 trials.
- "Ba" vs "Bee" in RT after 6 trials.
- "Ba" vs "Ga" in RT and RPF after 4 trials

• **Demonstrates the benefit of hearing aid fitting for speech discrimination of mid-level speech.**
• **Useful counselling tool.**

Infant with auditory neuropathy

How much can they hear? Do hearing aids help? Will a cochlear implant be better?



Detection of unaided "Ba" significant responses:

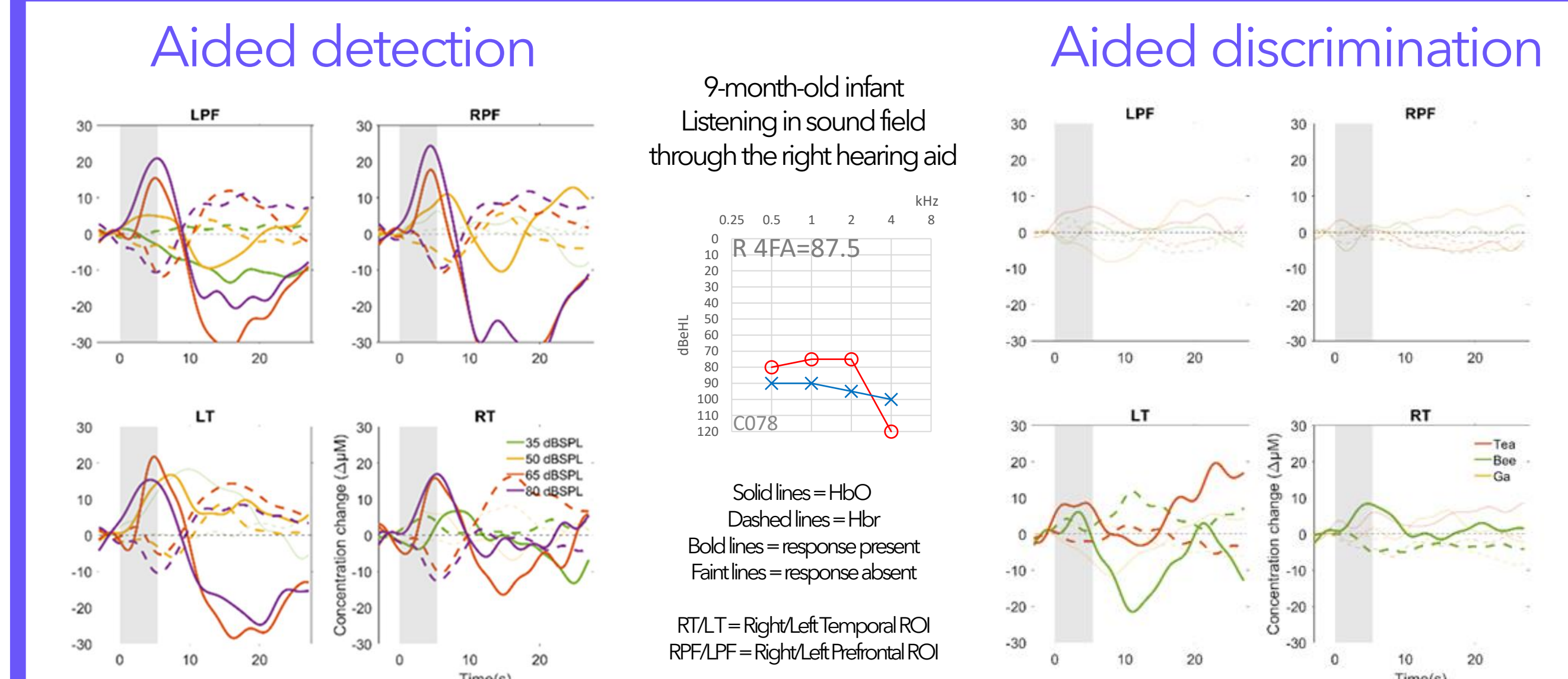
- 80 dB SPL in RT after 4 trials.
- 65 dB SPL no responses
- 35 dB SPL in RT after 9 trials out of 10 (likely false +ve)
- No responses to control level of 0 dB SPL.
- **Confirms significant functional hearing loss**

Detection of aided "Ba" significant responses:

- No responses to amplified sounds (hearing aid gains of 41-45 dB for 65 dB SPL input)
- False positive responses in the right hemisphere
- **Confirms no benefit from hearing aids**
- **Infant is communicating via Auslan**

Infant with severe hearing loss

Is their hearing aid well programmed and allowing speech discrimination?



Detection of aided "Ba" significant responses:

- 65 & 80 dB SPL in all ROIs within 3-5 trials.
- 50 dB SPL in all ROIs except RT within 5-9 trials.
- 35 dB SPL in LPF & RT within 7-10 trials
- **Infant is hearing low, mid and average level speech.**

Discrimination of aided 65 dB SPL significant responses:

- "Ba" vs "Tea" in LT only on trial 5.
- "Ba" vs "Bee" in LT on trial 4 & RT on trial 11.
- "Ba" vs "Ga" - no significant response in any ROI.
- **Infant can discriminate between the speech sounds "Ba" vs "Tea" and "Ba" vs "Bee".**

Future Directions

NIRGenie start-up company

- Bionics Institute & University of Melbourne investment

EarGenie® prototype

- Wireless headband with emitters & detectors
- Bluetooth connection with the clinical app
- Clinician selects detection or discrimination test and controls sound type and level.

Clinical trial

- Evaluating the usefulness of EarGenie test results for clinical decision in babies with hearing loss

Hearing Module research

- Frequency specific threshold estimation
- Comfort level estimation for cochlear implant mapping