SU34

Pioneering Cortical Assays of Gap Detection to Explore Temporal Processing in Chinchilla using a Multi-Channel Mini-EEG Cap

Varsha M Athreya, MS[1] Andrew Sivaprakasam, BS[2] Hannah Ginsberg, MS[3] Hari Bharadwaj, PhD[4] Michael Heinz, PhD[1,2]

[1]Speech , Language and, Hearing Sciences, Purdue University, [2]Weldon School of Biomedical Engineering, Purdue University
[3]Medtronic, [4]Communication Sciences and Disorders, University of Pittsburgh

Introduction

- Precise encoding of temporal envelope is essential for perception of speech and species-specific communication, and can deteriorate with age, peripheral pathology, or central auditory system changes.
- Animal models of hearing provide a controlled way to explore the consequences of aging and hearing loss on temporal processing.
- Here, we measured a cortical correlate of gap detection, a well-established tool for evaluating the encoding of envelope fluctuations, by recording EEG responses in chinchillas.
- While subcortical components of auditory evoked potentials in small-animal models using subdermal electrode placements are well-defined, the realm of animal studies concerning auditory-evoked cortical responses that are more spatially complex remains largely unexplored.
- To address this, we adapted a **32-channel mini-EEG cap** (Cortech Solutions' ActiveRat) to *non-invasively* record **cortical potentials** from chinchillas to gain insight into processing of real-world stimuli along the auditory pathway.

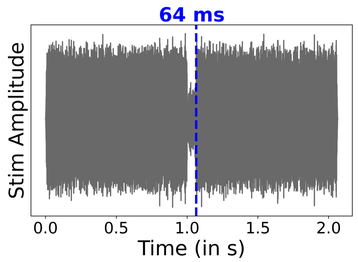
Methods

Participants:

Fifteen chinchillas across pre-existing groups in the lab –

Group	N	Mean Age (y) ±SD	Years since exposure
Young Normal-Hearing (YNH)	5	1.4±0.55	NA
Middle-aged Normal-Hearing (MNH)	5	5.65±0.34	NA
Exposed to TTS Noise (TTS)	5	3±0.17	1.9

Cortical Correlate of Gap Detection:
Measures the precision of temporal envelope (slow amplitude modulations of acoustic stimuli) coding.



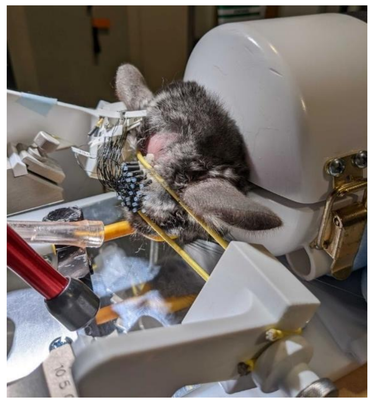
Stimuli: Gap durations of 16, 32, 64 ms in 4kHz tone embedded in 4kHz centered octave-band noise.

Data Acquisition: Data was simultaneously recorded from the mini-EEG cap and three subdermal electrodes (mastoid, vertex, ground) using the BioSemi ActiveTwo system following lab protocol.[1]

Sedation States:

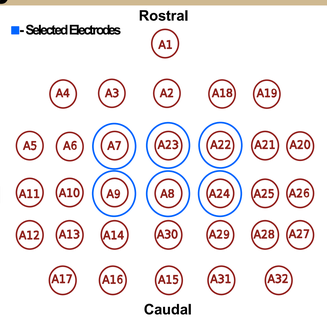
1. Deep Anesthesia (Anesthetized)
   - Xylazine (4 mg/kg, SQ)
   - Ketamine (40 mg/kg, SQ)
2. New Anesthesia protocol (Light sedation)
   - Ketamine (10 mg/kg , SQ)
   - Acepromazine (0.5 mg/kg, SQ)
   - Atropine (0.05 mg/kg, SQ)

Each data collection session lasted for around 2 hours under both the sedation conditions.

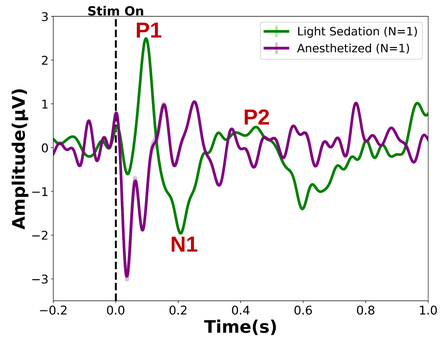


EEG Analyses

- To support cross-species translation, EEG data is analyzed using the same framework (MNE-Python)[2] used to process these measures in humans.
- Cortical responses analyzed from central channels (blue) of the mini-EEG cap, band-pass filtered from 2-20 Hz.



Effects of Sedation on Cortical Onset Response



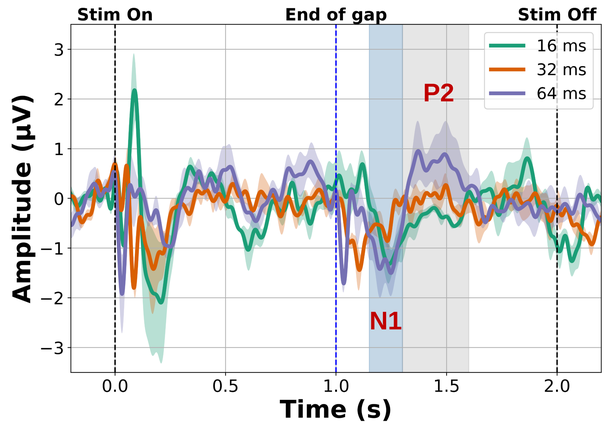
In a single YNH chinchilla:

1. Responses under the light-sedation (*green)* had identifiable cortical onsets (P1-N1-P2), analogous to human cortical onsets at P1: 50-80 ms, N1: 80-250 ms, P2: 200 ms.[3]
2. Cortical onset responses under deep anesthesia were often atypical or indiscernible *(purple example).*

Our further data collection was carried out under 'light-sedation'.

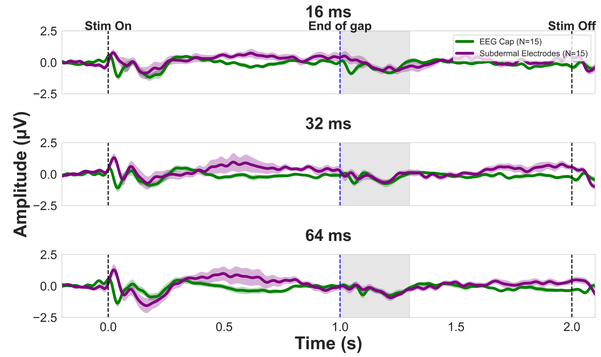
Cortical Correlate of Gap Detection

With increasing gap duration, mean (N=15) cortical gap responses followed trend of increasing P2 amplitude. However, these responses are not as distinguishable as human cortical gap responses *(See Poster SU127).*



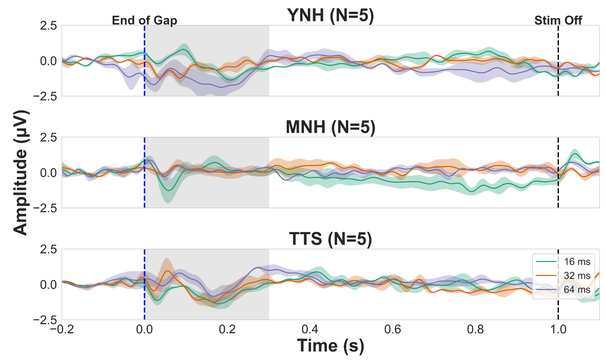
Comparing Mini-EEG Cap to Gold-Standard Subdermal Electrodes

Waveform morphology recorded by mini-EEG cap and subdermal electrodes are similar for all three gap durations. However, the response amplitude from the subdermal electrodes are larger.



Future Directions

Comparison of cortical gaps across three groups: There are differences in amplitude and latencies of gap responses across the groups. This suggests differential cortical effects of aging and noise exposure, which require future work.



Further data collection on a

- bigger pool of subjects with
  - precise assessment of peripheral status (DPOAEs, MEMR),
  - strict control of age and noise exposure to evaluate consequences of peripheral damage on cortical responses.

Conclusions

- Eliciting reliable cortical responses to fundamental gap stimuli in an animal model is the gateway to exploring cortical auditory processing to complex stimuli.
- This development enables research on the subcortical and cortical consequences of specific pathologies of the auditory system, like loss of outer/inner hair cells, loss of synapses, by using controlled-hearing-loss animal models to dissect the subtypes of SNHL.
- Furthermore, the EEG mini-cap not only facilitates animal research but also enhances its translational potential owing to homogenous data collection using 32-channel cap, instrumentation, and data analysis pipelines. This fosters a more comprehensive understanding of auditory processes and dysfunction across species.

Acknowledgements: Funded by NIH R01DC015989 (HB), NIH R01DC009838 (MH), NIH T32DC016853 (AS), NIH F30DC020916 (AS)
References: [1] Ginsberg et al. J Neu Meth 2023 [2] Gramfort et al. Front Neurosci 2013 [3] Davis PA. J Neurophysiol 1939