A Chinchilla Mini-EEG Cap Improves Cross-Species Translation For Cortical and Subcortical Evoked Potentials

Poster SU188

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Introduction

Electrophysiological data are better translated when protocols and data analyses are as identical as possible between animal models and human subjects.

- Powerful, repeatable, and open-source frameworks, like **MNE[1]**, while designed for human EEG and MEG, can also be utilized to analyze animal data– so long as hardware and raw data formats are similar enough

- Additionally, while human cortical event-related potentials to simple stimuli and changes in stimuli (e.g. **Mismatch Negativity (MMN), Acoustic Change Complex (ACC)**) are often used in EEG studies of normal and impaired hearing, cortical potentials are less studied in the important chinchilla model of human hearing[2].

- A better understanding of subcortical and cortical measures in chinchillas and other animal models has the potential to bolster cross-species studies of hearing loss pathologies including cochlear damage and synaptopathy.

Methods

Chinchillas: (N = 5, 1 Female): Normal hearing status. Acclimated to an awake-restraint tube[3] for 15-20 min 2 days prior to experiment.

- **Anesthesia:** Ketamine/Xylazine administered 15 minutes prior to data collection. Hair under cap region was removed after sedation. 2 hours of data (per animal) were collected under anesthesia.

- **Anti-Sedation:** Atipamezole was administered to reverse sedation. Anesthetic reversal was confirmed by observation of a full tail-reflex and noticeable changes in behavior. Data was collected for another 2 hours, unless significant discomfort was observed.

Electrode Montage: A 32-channel ActiveRat[4,5] (Cortech Solutions) EEG mini-cap was placed and referenced to cup electrodes on the earlobes. A previously-used three-electrode (+ Vertex, - Mastoid, GND Nose) subdermal montage was simultaneously placed for comparison.

Cortical Measures:

Acoustic Change Complex (ACC): a 6 harmonic complex tone with F0 = 103 Hz was presented with a 20% shift up or down in pitch after 500 ms at 80 dB SPL.

Mismatch Negativity (MMN): a 75 ms 30 harmonic complex tone with F0 = 200 Hz was presented 6-8 times before a rare 75 ms deviant tone either 1, 5, or 10% higher or lower. All tones presented at 80 dB SPL.

Temporal Coherence (COH): a 12-tone (300-17000 Hz) complex with comodulation statistics parametrically varied without changing the modulation of individual tones. The tones were separated by 1.5 ERBs to ensure minimal peripheral interactions between the tones. The stimulus was 5 seconds long, with alternating coherence-incoherence patterns[6].

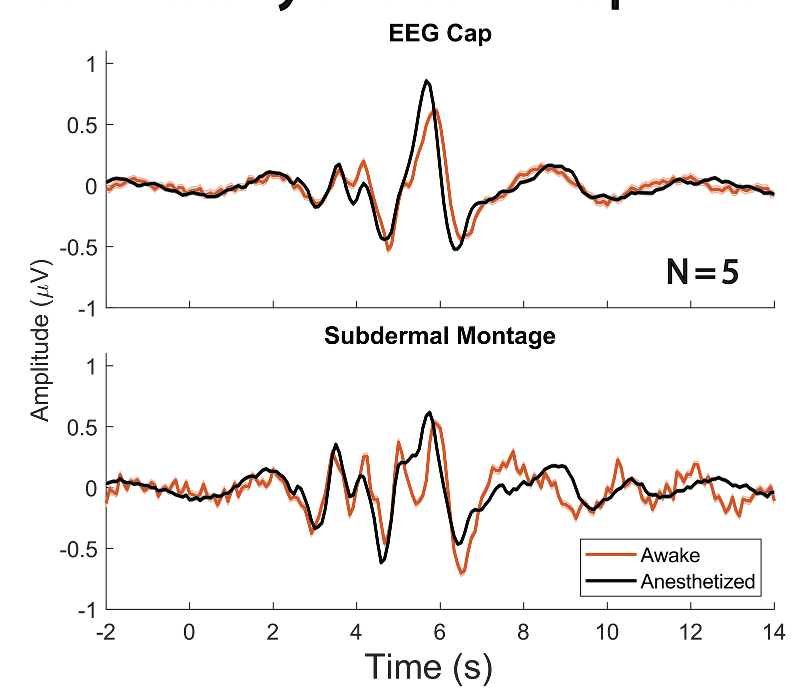
Subcortical Measures:

Auditory Brainstem Response (ABR): elicited by 115 dB peSPL clicks.

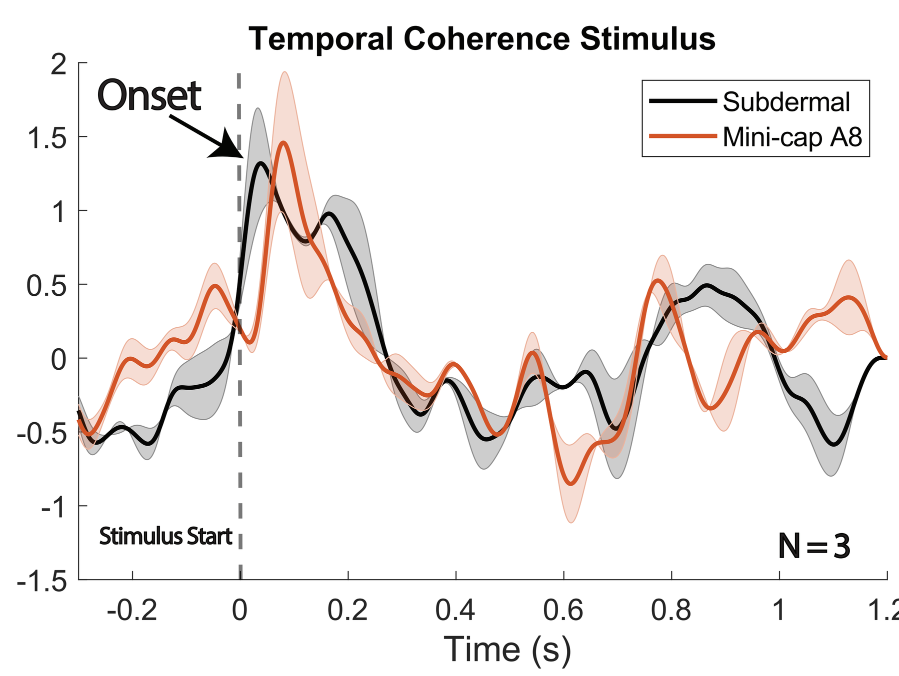
Envelope Following Response (EFR): elicited by ACC and MMN stimuli

Results

A. Auditory Brainstem Responses



B. Cortical Onset Response



A. A comparison of awake vs anesthetized ABRs between the mini-cap and subdermal electrodes. Both montages results in similar morphologies and amplitudes.

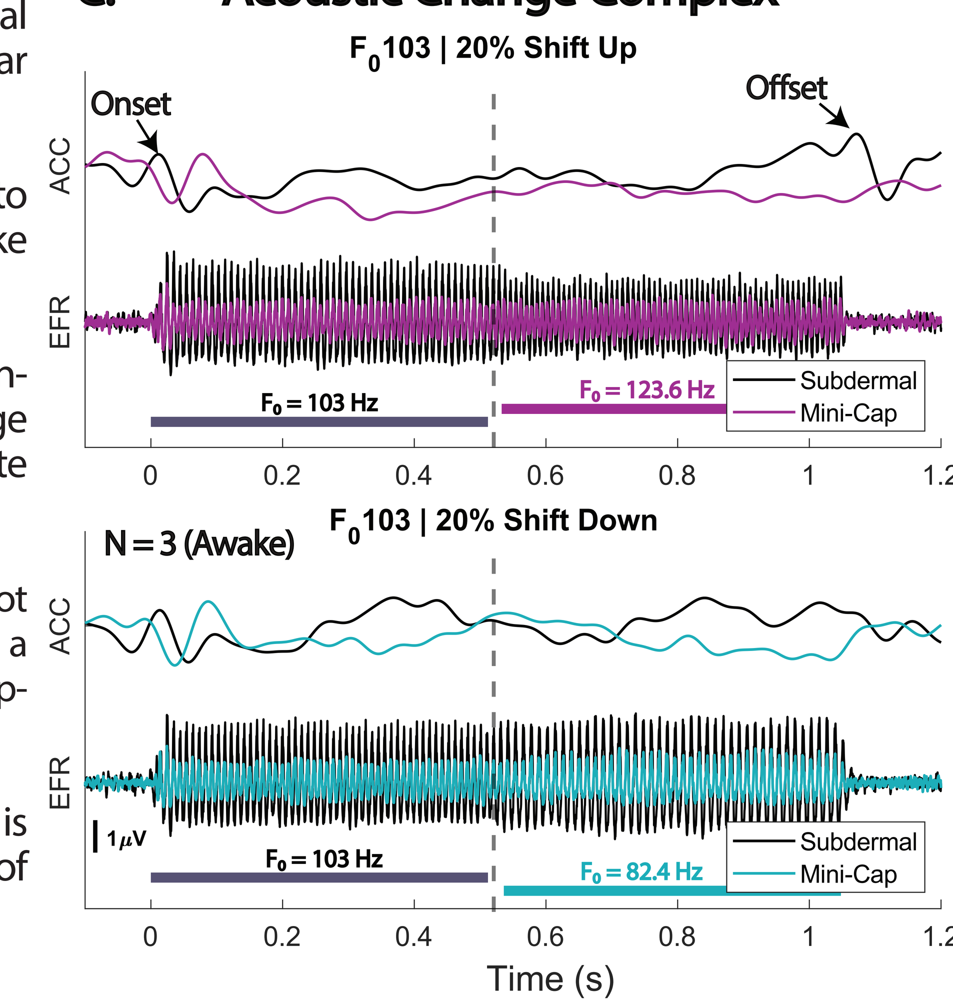
B. An example of a cortical onset response to the temporal coherence stimulus in awake chinchillas.

C. While cortical onset and offset may be identified in response to a stimulus, pitch change does not appear to elicit a strong ACC, despite a clear EFR.

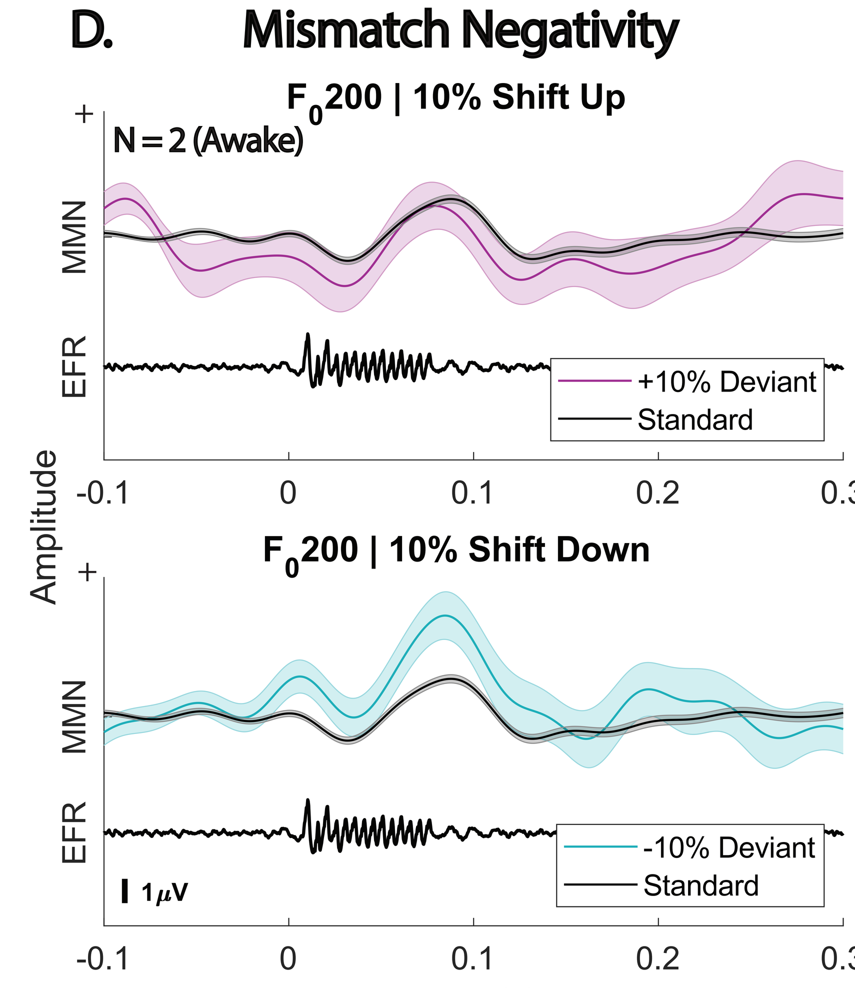
D. While MMNs to upward pitch changes are not apparent, downward pitch changes may elicit a more positive response using the mini-cap, opposite in direction to observed human MMNs.

E. An advantage of multi-channel recording is the ability to more precisely localize areas of activity and enhance response SNR.

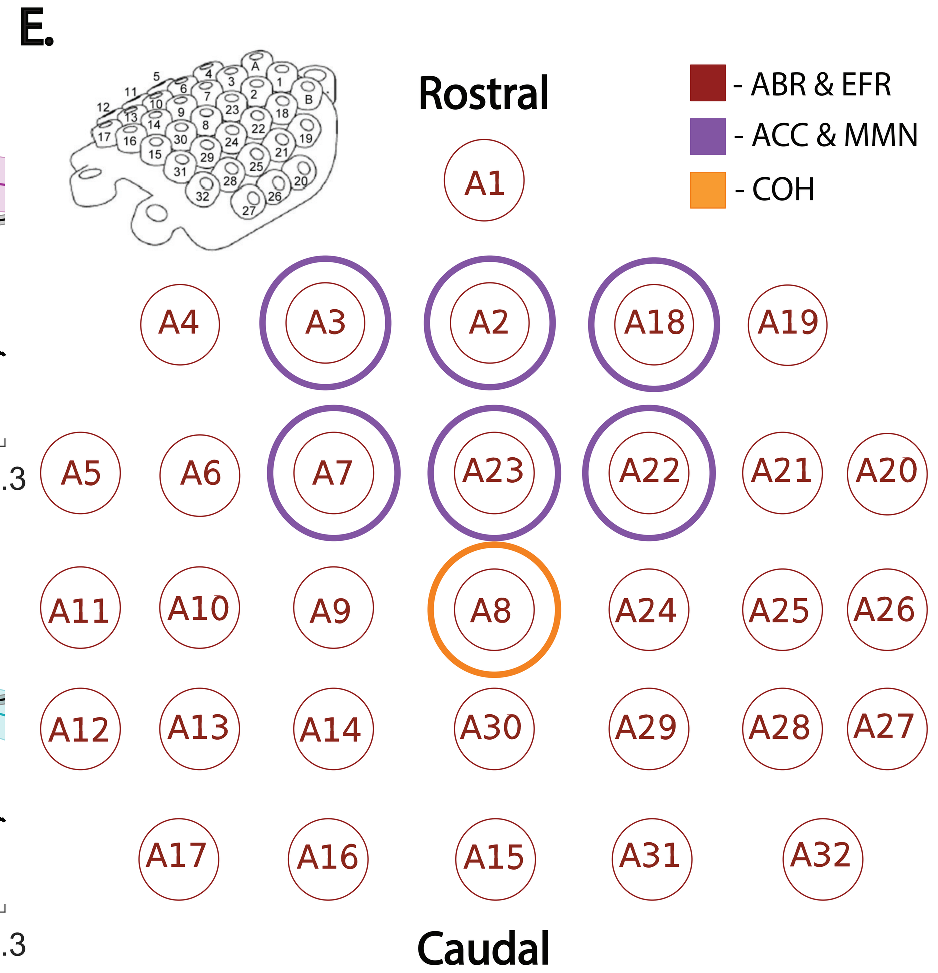
C. Acoustic Change Complex



D. Mismatch Negativity



E.



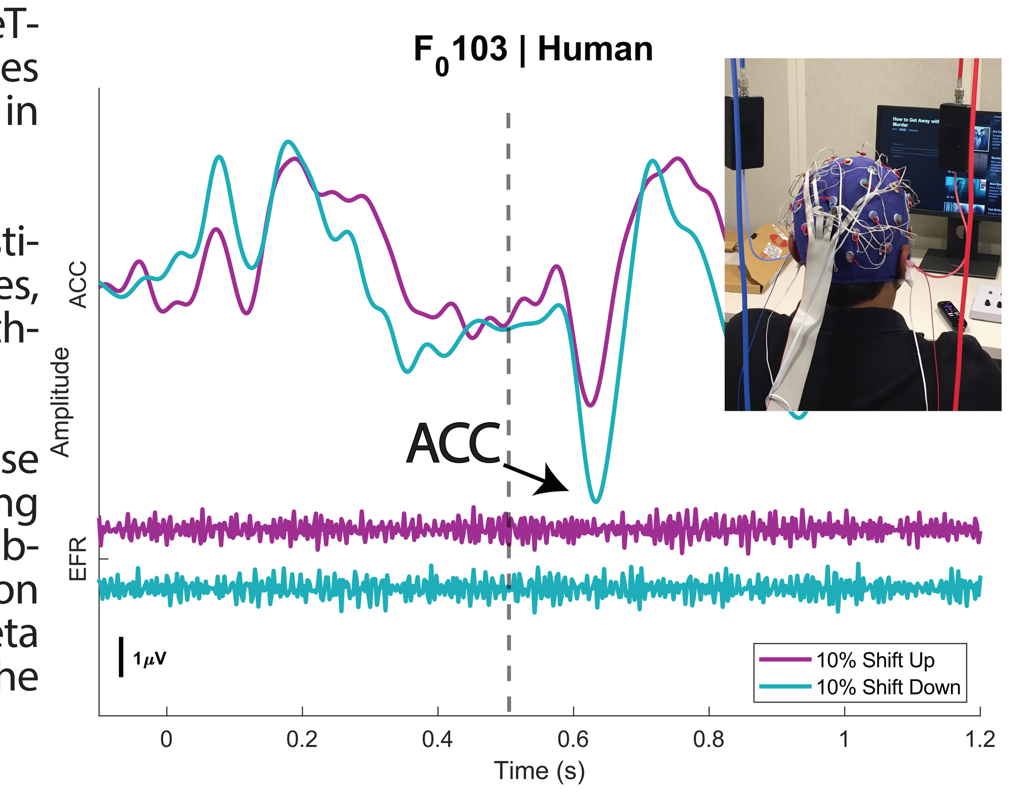
Cross-Species Comparison

The same AD-box (BioSemi ActiveTwo) and data processing pipelines were used to assess EEG waveforms in both species.

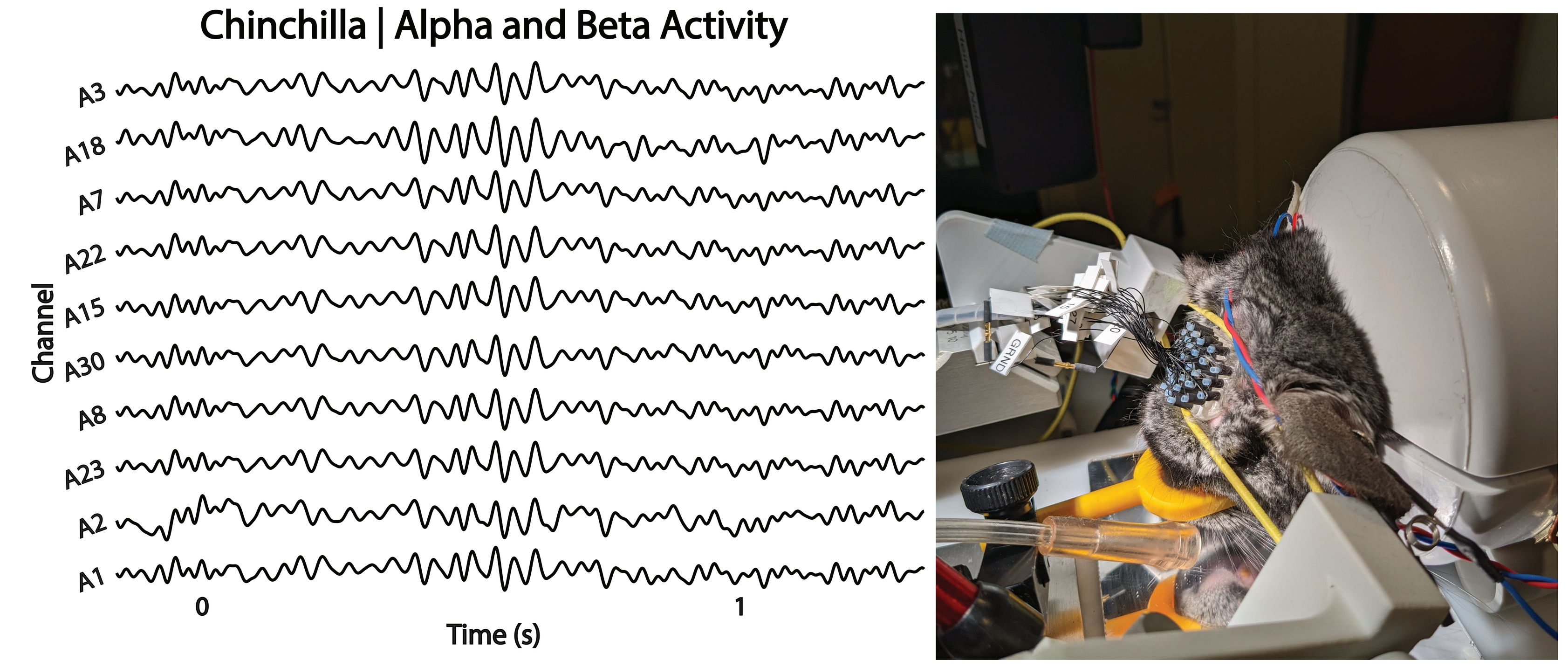
As this allows a more efficient investigation of chinchilla cortical responses, it has significant potential to strengthen translational research.

While an ACC comparable to those found in humans (right) when using an identical paradigm was not observed in these 5 initial (post-sedation awake) animals, similar alpha and beta oscillations were observed using the mini-cap (below).

Human | Acoustic Change Complex



Chinchilla | Alpha and Beta Activity



Conclusions

Feasibility:

- The mini-EEG cap was previously validated[5] with our paragon subdermal electrode ABR and EFR proctcol. We expanded its utility to study complex stimulus paradigms of ongoing human research on pitch perception and temporal coherence processing.

- Reliable and robust subcortical measures of ABR and EFRs can be measured with ease using the mini-EEG cap.

- The hardware used for acquisition and software used for analysis (MNE, Python) were identical to those we use to process human EEG waveforms.

- Therefore, our setup and pipeline should enhance the rigor of future cross-species work involving subcortical and cortical responses.

Scientific Insight:

- Cortical onset responses were evoked by three different stimulus paradigms in anesthetized and awake chinchillas.

- However, with our preliminary acquisition and analyses, complex cortical responses in chinchillas were not similar to robust human responses to changes within the stimuli (e.g., pitch changes, degrees of temporal coherence). Further work towards improving our protocols to extract these delicate responses is vital in evaluating the complexity of cortical processes in chinchillas.

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