PULSE-RATE DEPENDENT INTEGRATION OF ITD AND ILD CUES IN THE MOUSE AUDITORY MIDBRAIN

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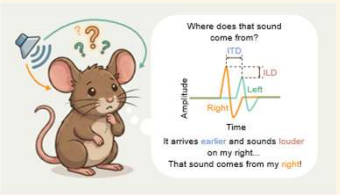
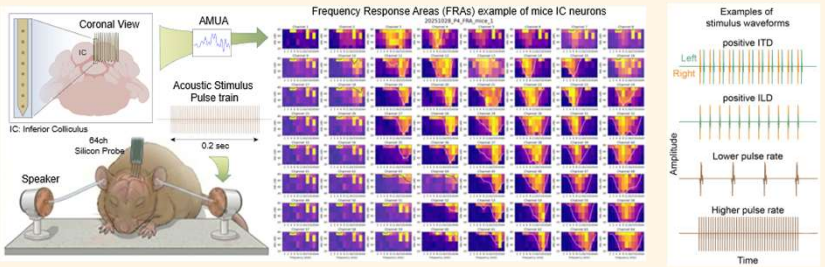
Introduction

Mice are gaining importance as an animal model in auditory research given their suitability for genetic techniques, but how suitable they are for studying binaural hearing remains uncertain. Here, we investigated the integration of interaural time (ITD) and level (ILD) differences in the mouse inferior colliculus (IC) with acoustic pulse (click) trains of varying rates.



Methods

5 CBA mice aged 6–8 weeks were used in this experiment. The animals were anesthetized with ketamine and xylazine. Acoustic pulse trains (ABL = 70 dB SPL) were delivered through two EC1 speakers with varying interaural time differences (ITD), level differences (ILD), and pulse rates in a closed-field configuration.

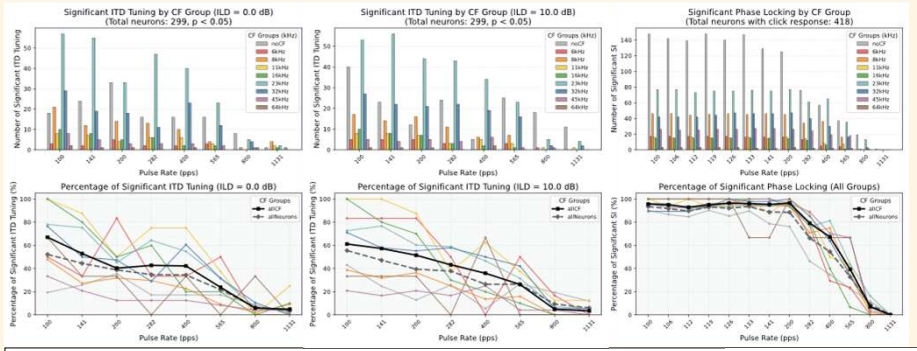


Multiunit activity was recorded using 64-channel silicon electrodes in the inferior colliculus (IC). The signals were bandpass filtered (300–6000 Hz), rectified (absolute value), and low-pass filtered at 4 kHz to obtain analogue multiunit activity (AMUA). These parameters were chosen to preserve phase locking.
418 neurons responsive to 900 pps pulse trains were included in the analysis.

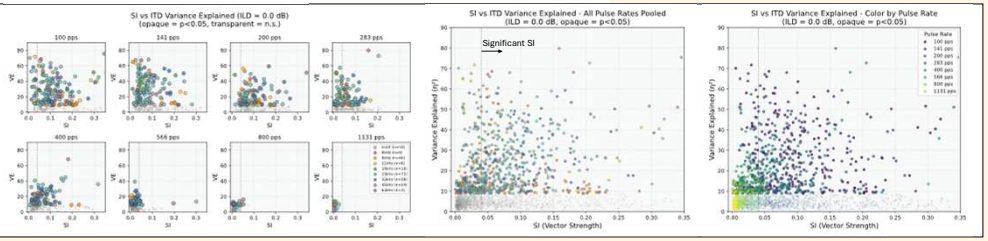
Results

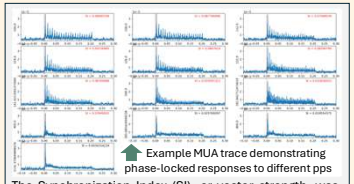
ITD sensitivity and Phase locking both decrease with pulse rate but are not mutually predictive

- ITD sensitivity declined for pulse rates above ~500 pps.
- Introducing a 10 dB ILD had minimal effect on the trend.
- Phase-locking declined for pulse rates above ~300 pps.

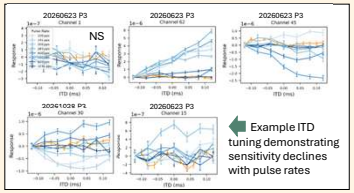


- However, direct comparison between phase-locking SI and ITD sensitivity revealed no apparent relationship.



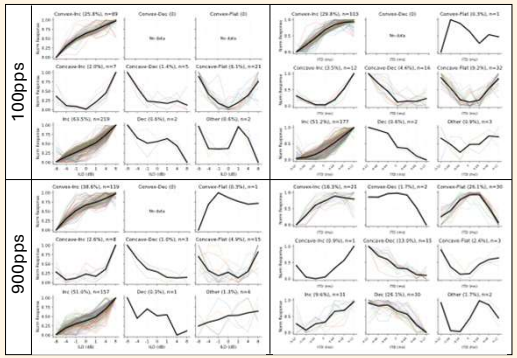


The Synchronization Index (SI), or vector strength, was defined as the amplitude of the FFT component at the stimulus pulse rate normalized by the sum of the AMUA.



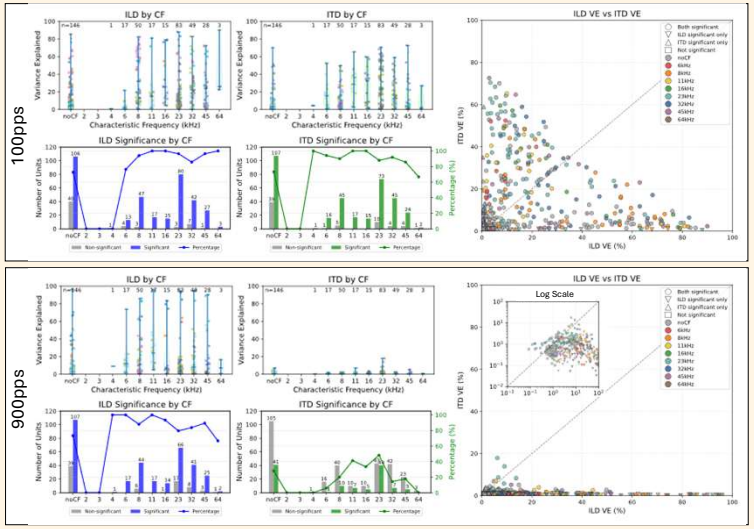
Results

Distribution of ILD/ITD tuning curves shapes



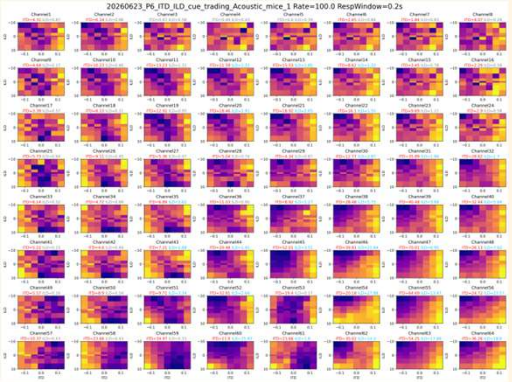
	Shape ⬆	Significance ➡
100 pps	ILD and ITD predominantly exhibiting monotonic increasing tuning shape that favor the contralateral stimulus.	Most units are tuned to both ITD and ILD.
900 pps	ILD tuning remained with monotonic tuning; ITD tuning showing more peaked tuning centered near 0 ITD.	ILD tuning remained robust; ITD tuning significantly decreased.

Sensitivity to ITD and ILD cue trading stimulus



Variance explained (VE) values were computed as they would be for a standard analysis of variance (ANOVA), which treats ITD and ILD as independent factors and the neural responses of AMUA amplitude as the dependent variable.

- VE did not differ markedly across CF groups. However, the significant percentage showed a declining trend for ILD sensitivity at 900 pps and for ITD sensitivity at 100 pps.
- At 100 pps, a large fraction of neurons exhibited dual sensitivity to both ITD and ILD cues, rather than being exclusively tuned to a single binaural cue.



A small subset of neurons showed shifts in their tuning peaks when both cues were varying, indicating an ITD/ILD cue interaction.

Conclusions

- Like other previous studies, we found widespread and robust ILD sensitivity in mice IC.
- At low pulse rates, we also observed a fair amount of ITD sensitivity as well as synergistic interactions between ITD and ILD cues in a subset of neurons.
- ITD sensitivity decreases with pulse rate, whereas phase locking showed the similar trend. But the two features are not mutually predictive.

Acknowledgement?