Encoding of Masked Amplitude Modulation in the Inferior Colliculus of the Budgerigar

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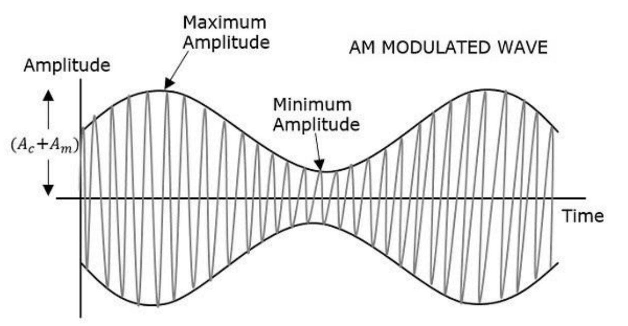
Introduction

- Amplitude modulation (AM) is an important acoustic feature of speech, animal vocalizations and many real-world listening environments (Shannon et al. 1995).



Amplitude Modulation

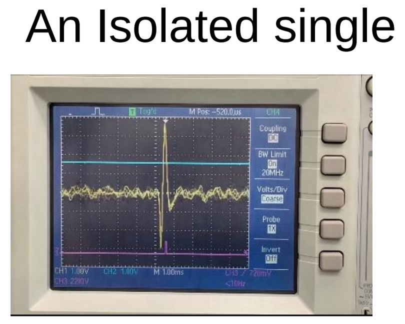
Knowledge gap

- Budgerigars provide an interesting animal model for AM detection studies based on similar AM detection abilities to humans (Carney et al. 2013).
- The budgerigar is an avian lifelong vocal learner with complex, temporally modulated vocalizations (Farabaugh et al. 1994; Tu et al. 2011)
- The inferior colliculus (IC) is an important processing center for AM. Previous studies examined multi-unit neural encoding of AM in the budgerigar IC, but single-unit studies are lacking.
- IC responses to masked AM are needed to test the modulation filterbank hypothesis, but masked AM responses are understudied

Methodology

- Anesthetized recordings with ketamine and dexmedetomidine
- Isolate single-unit responses in the IC with glass electrodes (10-30 MΩ).
- Characterize physiological response properties including tuning curves, frequency response maps, modulation transfer functions (describing AM sensitivity), and AM masking patterns (describing AM sensitivity in noise)
- AM masking stimuli were produced by applying a sinusoidal masker AM and sinusoidal target AM to the carrier signal (CF tone or noise) in quadrature phase.

An Isolated single unit



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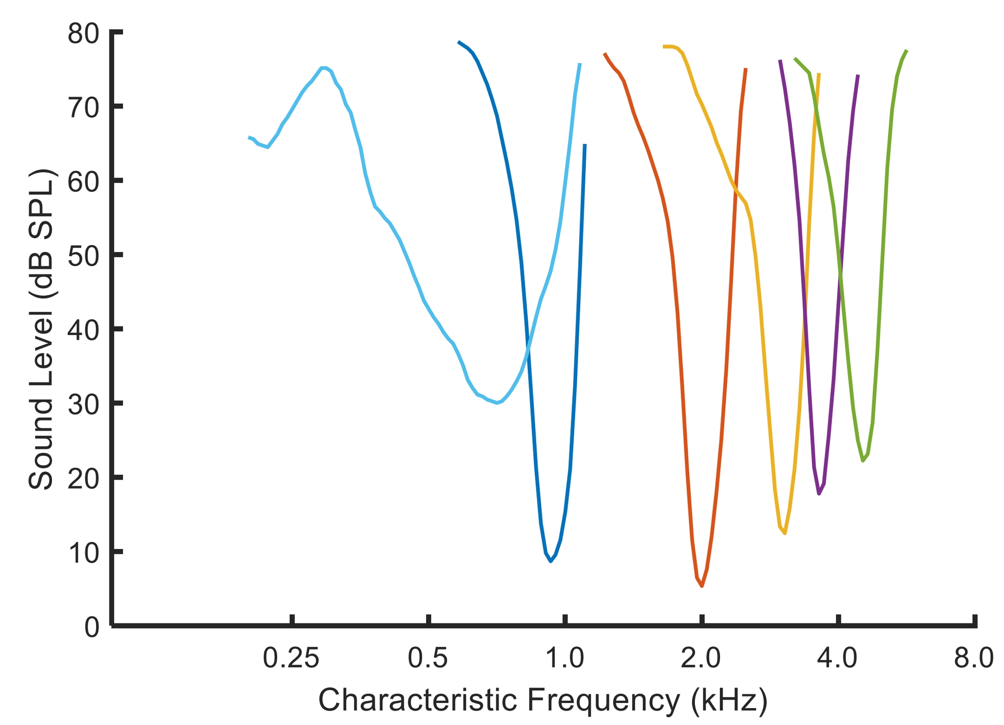
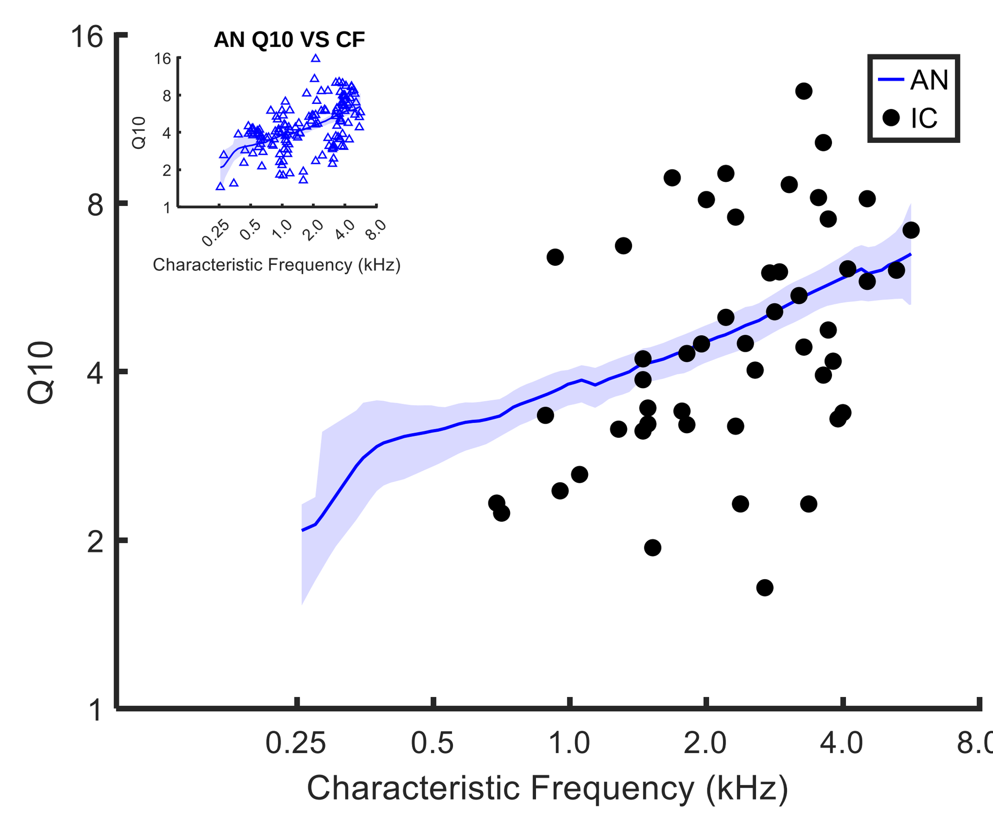
A — Tuning Curves



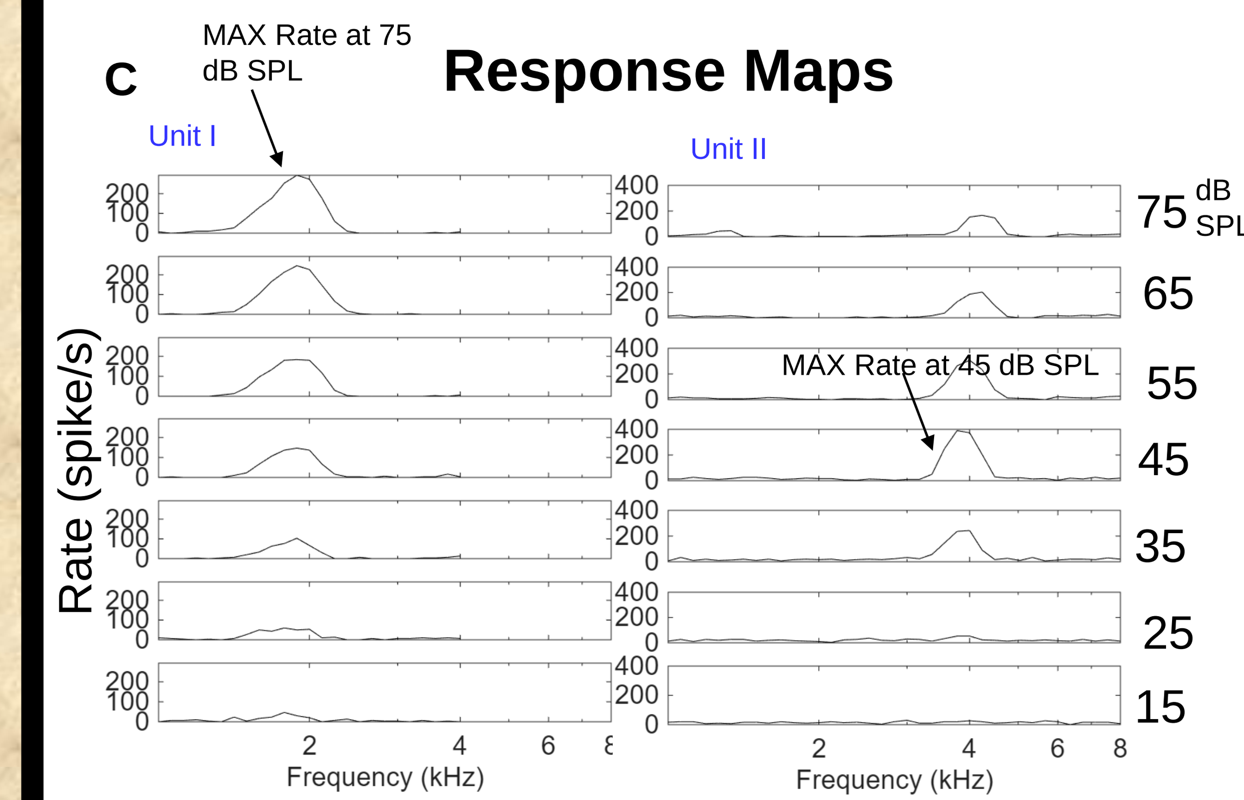
A: Representative pure tone tuning curves in the budgerigar IC single neurons are V-shaped and roughly symmetrical on a log frequency axis.

B — Q10 VS CF in IC



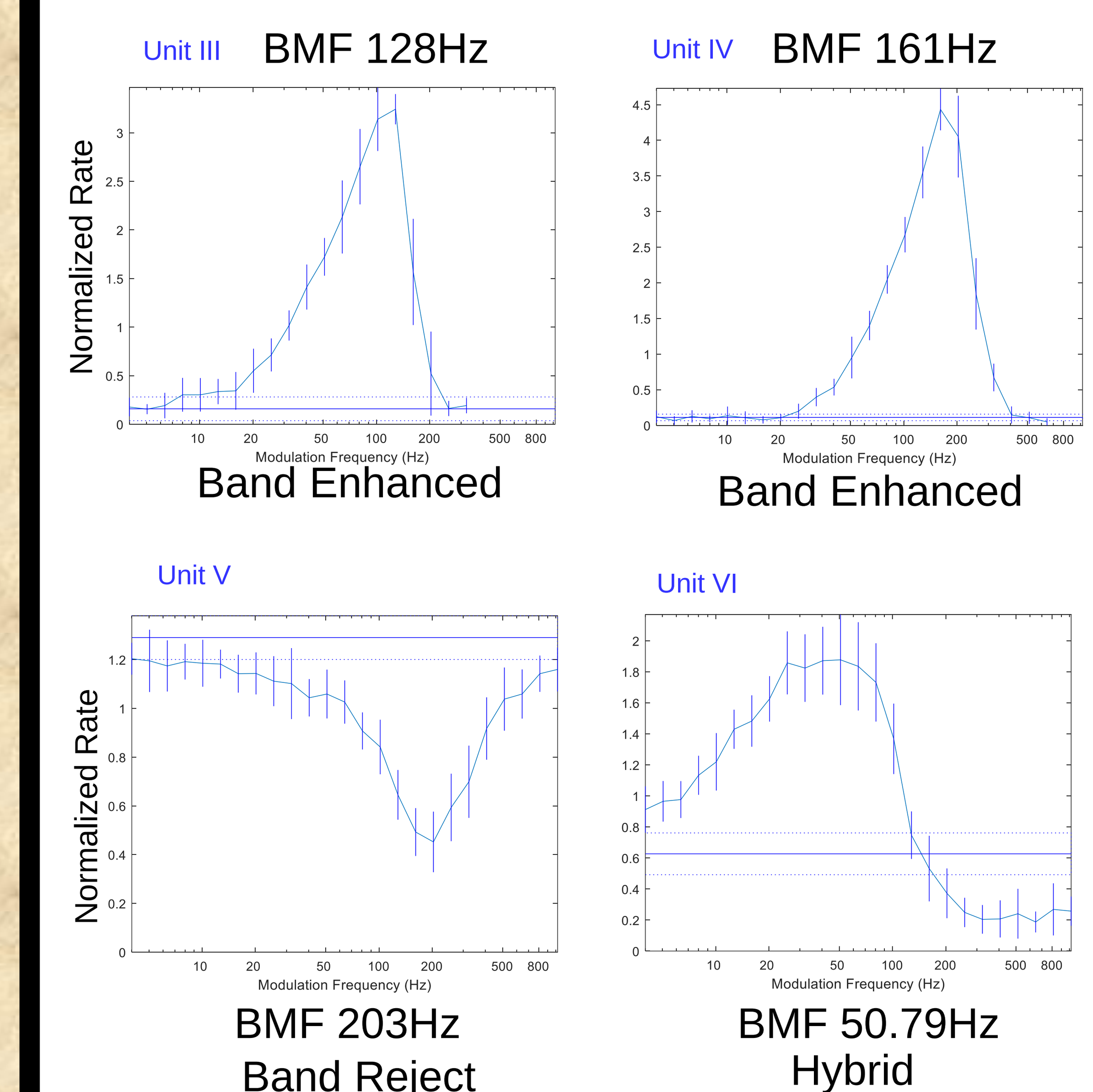
B: Tuning curve sharpness of IC single units increases with higher characteristic frequency (CF; n= 49 sites).
IC tuning-curve sharpness is similar to auditory-nerve tuning-curve sharpness in budgerigars (Karosas et al., 2025).

C — Response Maps



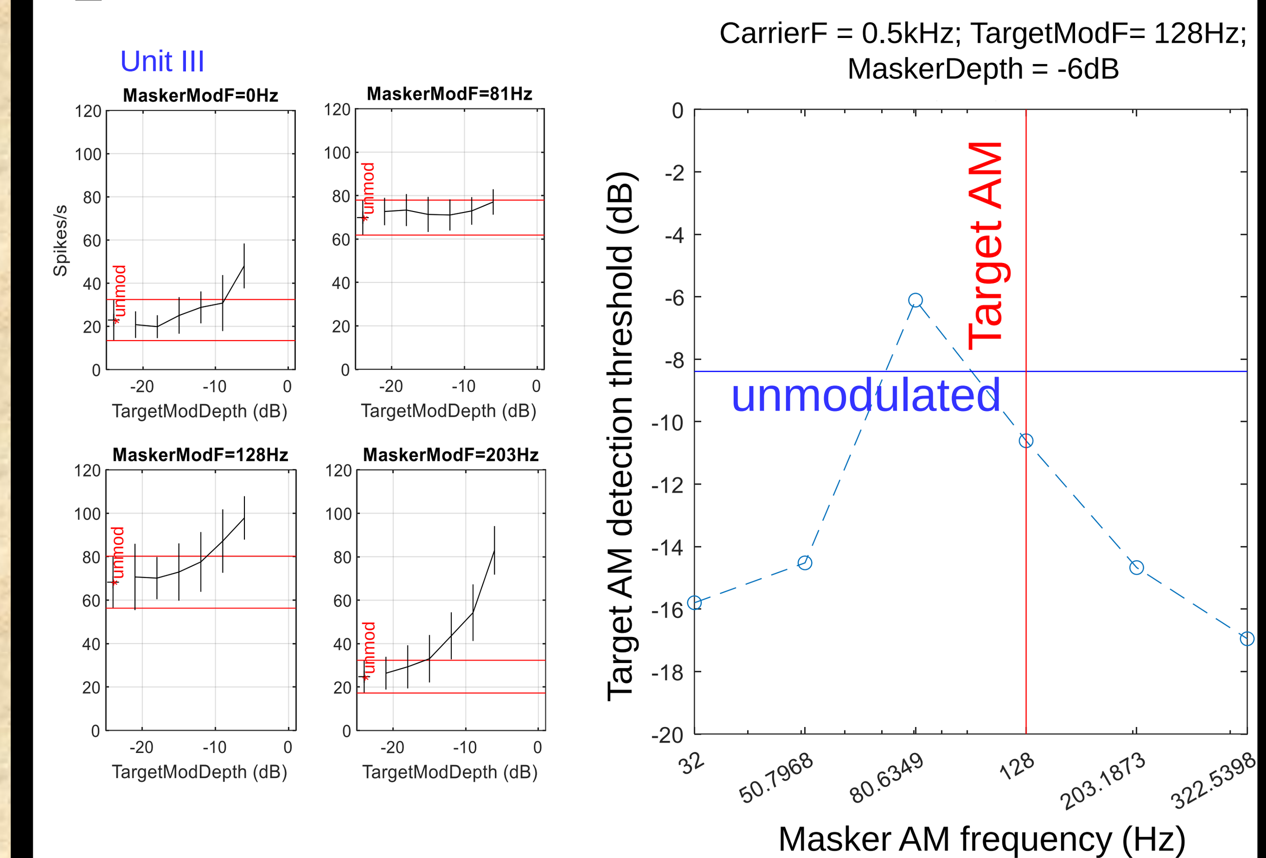
C: IC frequency response maps from pure tones of varying frequency and level. Neurons show maximum rate at higher sound levels and others at mid-range sound levels.

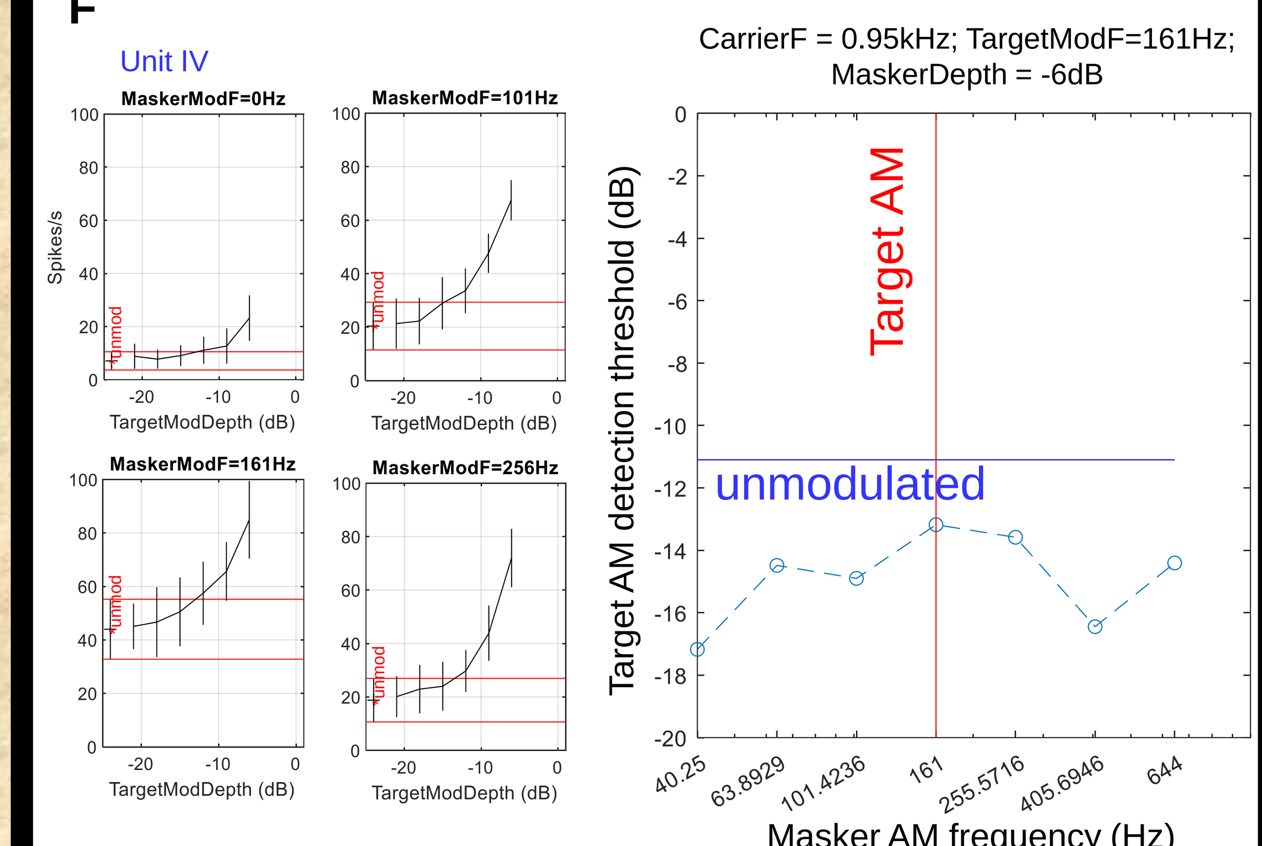
D — Modulation Transfer Functions



Single-unit IC modulation transfer functions (MTFs) in response to AM. MTFs show variety of response patterns including band enhanced, band reject, and hybrid (i.e., enhance and suppressed regions) shapes.

AM Masking





Target AM detection thresholds vary with the masker AM frequency, in some cases consistent with the modulation filterbank hypothesis

Conclusion

IC single-unit MTFs in the budgerigar are more heterogeneous than MTFs of multi-units.

AM masking patterns of some IC single units are consistent with the modulation filterbank hypothesis.

Acknowledgements

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