Duration Tuning at Non-Best Frequencies in the Inferior Colliculus of *Eptesicus fuscus*

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Introduction

Duration tuned neurons (DTNs) provide a potential mechanism for encoding sound duration in the central nervous system. DTNs are selective for stimulus duration, and like all central auditory neurons, are tuned to stimulus frequency. The best duration (BD) and best excitatory frequency (BEF) are the stimuli eliciting maximum spiking. Responses of DTNs have been well characterized at their BEF, but much less is known about responses at non-BEFs.

Questions

1. Does the temporal bandwidth, best duration, or first spike latency of a DTN change at non-BEFs?
2. Are there differences in the spiking response patterns between DTNs and non-DTNs recorded at non-BEFs?

Methods

- Single-unit extracellular recordings were collected from 21 DTNs and 12 non-DTNs from the inferior colliculus of the big brown bat (*Eptesicus fuscus*)
- Stimuli were varied in frequency and duration
- We measured BD, temporal bandwidth (BW), and first spike latency (FSL) at the BEF and at select frequencies relative to the BEF (see **Fig. 1**) . For non-DTNs, we analyzed the minimum response duration instead

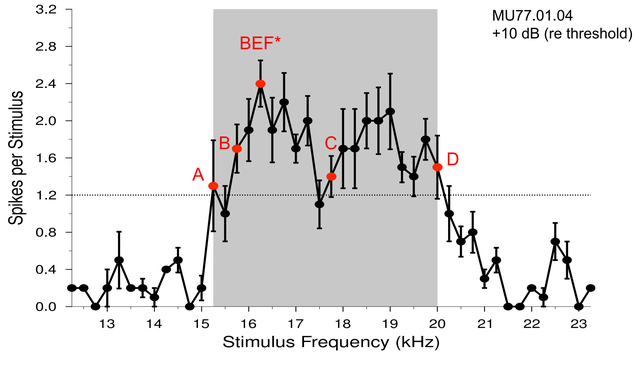

Figure 1. Measuring the Excitatory Frequency Response Area. Mean (± standard error, SE) spike count as a function of pure tone frequency. The BEF is marked (*). Frequencies eliciting ≥50% of the maximum (*dotted line*) were scored as within the excitatory frequency response area of the cell. Non-BEFs included the highest (A) and lowest (D) frequencies, the midpoint between the lowest frequency and BEF (B), and the midpoint between the highest frequency and BEF (C). An identical paradigm was used to measure each cell's excitatory temporal bandwidth.

Neuron Response Classes

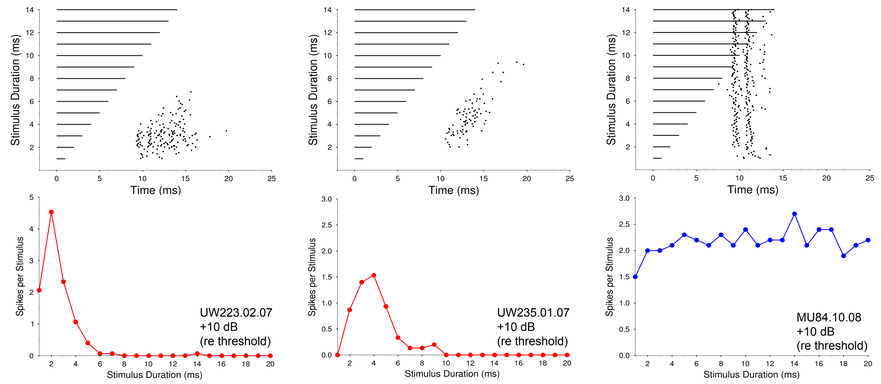

Figure 2. Auditory Neuron Response Classes. Dot raster displays (*top*) of the spiking responses of a short-pass DTN (*left*), a bandpass DTN (*center*), and a non-DTN (*right*) to BEF pure tones of varying durations. Mean spike counts (*bottom*) of DTNs (red) and non-DTNs (blue) in response to BEF pure tones (n = 10 trials per stimulus duration).

Result 1: Temporal Bandwidth

Figure 3. Temporal Response Bandwidth as a Function of Frequency. A repeated measures ANOVA showed no differences in temporal response bandwidth for both DTNs ($F(4,80) = 2.237$, $p = 0.072$) and non-DTNs ($F(4,44) = 2.156$, $p = 0.090$), indicating that temporal bandwidths did not vary when cells were stimulated at non-BEFs; however, the existing trend suggests DTNs are more selective at non-BEFs, and that non-DTNs are more selective at frequencies lower than BEF.

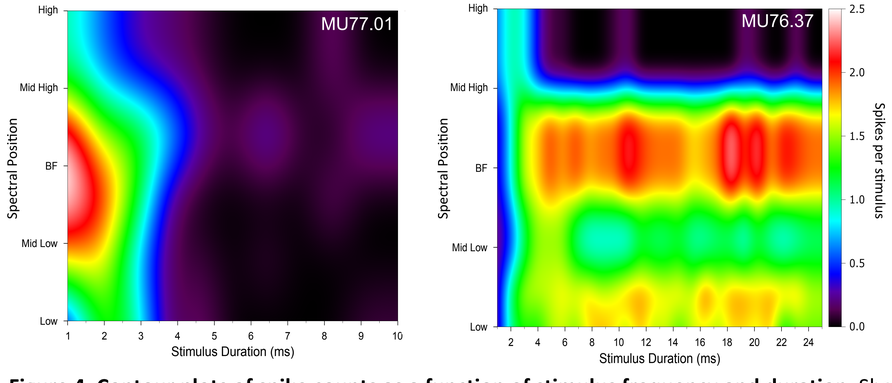

Figure 4. Contour plots of spike counts as a function of stimulus frequency and duration. Shown are the spiking responses of a DTN (MU77.01, *left*) and a non-DTN (MU76.37, *right*) tested at five frequencies (re BEF; see **Fig. 1**). Spikes counts ranged from 0 (*black*) to 2.5 (*white*). For both cells, the maximum response occurred at the BEF and decreased as the stimulus was increased or decreased away from the BEF. The largest temporal bandwidth also occurred for BEF tones.

Result 2: Best / Minimum Duration

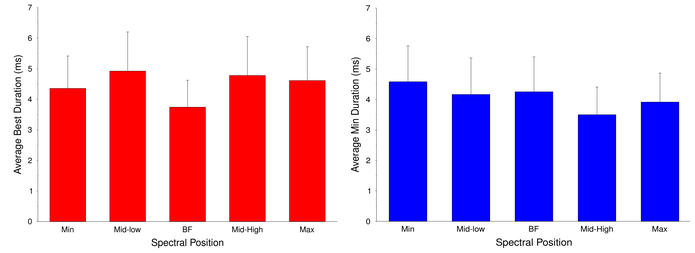

Figure 5. Best /minimum duration as a function of frequency. Mean (± SE) spikes per stimulus in response to pure tones at the BEF and at non-BEFs. A repeated measures ANOVA indicated no significant differences in BD/MD across frequency for DTNs ($F(4,80) = 1.011$, $p = 0.407$) and non-DTNs ($F(4,80) = 0.327$, $p = 0.858$).

Result 3: First Spike Latency

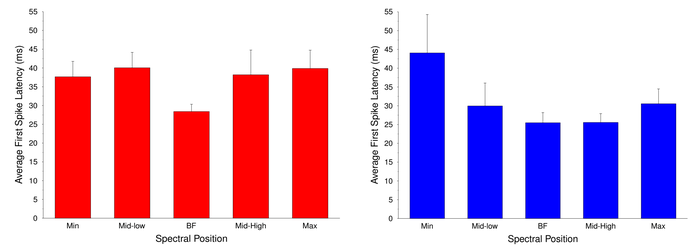

Figure 6. First spike latency as a function of frequency. Mean (± SE) FSL in response to pure tones at the BEF and at non-BEFs. A repeated measures ANOVA indicated no significant differences in FSL across frequency for DTNs ($F(4,80) = 1.529$, $p = 0.202$) and non-DTNs ($F(4,80) = 2.020$, $p = 0.108$).

Conclusions

- While not quite significant, there was a trend for DTNs to have narrower temporal bandwidths at non-BEFs compared to non-DTNs
- The BD and FSL of DTNs and non-DTNs did not change at non-BEFs as long as pure tone stimuli fell within the excitatory frequency response area of a neuron

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