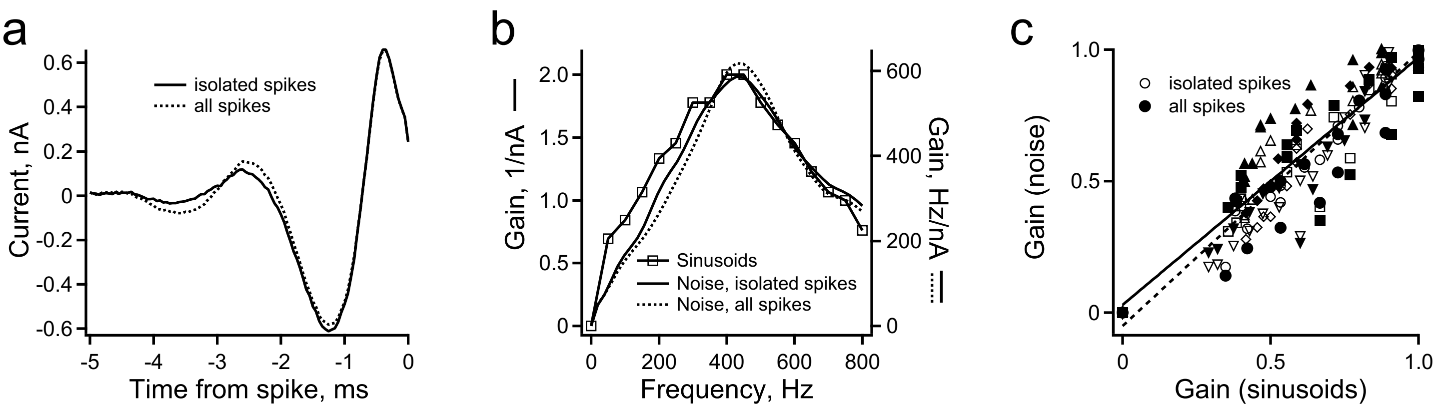
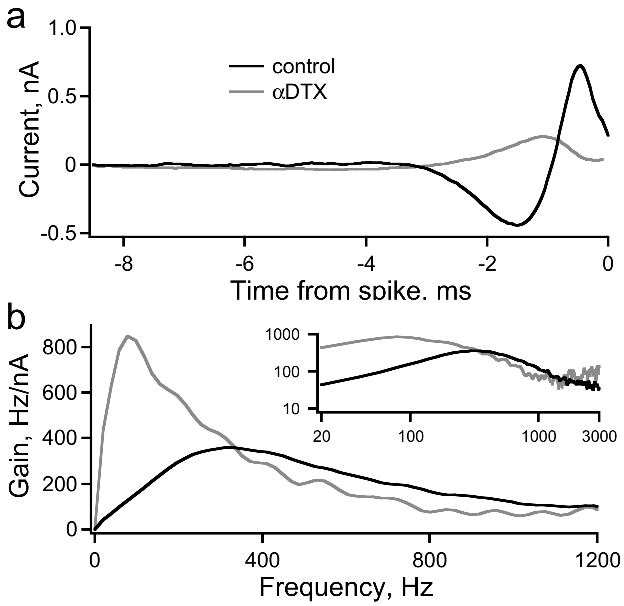

a
Current, nA
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
isolated spikes
all spikes
-5
-4
-3
-2
-1
0
Time from spike, ms
b
Gain, 1/nA
2.0
1.5
1.0
0.5
0
Gain, Hz/nA
600
400
200
0
Sinusoids
Noise, isolated spikes
Noise, all spikes
0
200
400
600
800
Frequency, Hz
c
Gain (noise)
1.0
0.5
0
isolated spikes
all spikes
0
0.5
1.0
Gain (sinusoids)


a
b
control
αDTX
Current, nA
1.0
0.5
0
-0.5
-8
-6
-4
-2
0
Time from spike, ms
Gain, Hz/nA
800
600
400
200
0
0
400
800
1200
Frequency, Hz
1000
100
10
20
100
1000
3000

Supplementary Figure 1. *The effect of spike history on the STA and gain measurements.* Recent spike history is known to affect features of the spike-triggered average (Powers et al., 2005). To test for the effects of spike history, we computed both the STA and the frequency-dependent gain using all spikes and using only spikes isolated by at least 10 ms from the preceding spike. Supplementary Figure 1a shows the STA from an NL neuron computed in both ways. The tail of the STA computed from isolated spikes is slightly more damped than the STA computed from all spikes. This behavior was typical in neurons with obvious spike history affects. Supplementary Figure 1b shows the frequency-dependent gain computed from both the STAs as well as the gain measured by threshold-crossing using sinusoids (see *Materials and Methods* for more details). In this neuron the 3 gain functions are similar. In general we found that the gain computed from the noise stimulus using all (filled symbols) or isolated spikes (open symbols) was in close agreement with the gain obtained from threshold-crossing using sinusoids. However, the isolated spike gain provided a better match. Linear regressions showed that the threshold-crossing gain was more strongly correlated with gain calculated using isolated spikes in response to noise (dashed line, $R^2 = 0.92$) than with gain based on all spikes elicited by noise (solid line, $R^2 = 0.81$), (Supplementary Figure 1c)**.** These results suggest that recent spike history may influence the effective frequency tuning of NL neurons when they fire at high rates, but that this effect was small within the range of stimulus parameters used to measure gain in the present study. All noise responses presented in the results section were analyzed using spikes isolated by at least 10 ms

Legend.

(**a**) The STA current versus time relative to all spikes (dotted line) or spikes isolated by at least 10 ms (solid line) computed from the response to current noise stimulation. (**b**) The frequency-dependent gain calculated from spike responses to sinusoidal current (squares and solid line) and from noise current using all spikes (dotted line) or isolated spikes (solid line). (**c**) The gain at each frequency calculated from responses to noise versus gain calculated in response to sinusoids in a population of 5 NL neurons. Each set of symbols indicates the responses of the same neuron to different frequencies. Filled and open symbols indicate gain calculated using all spikes or isolated spikes, respectively. The lines are linear fits to the data points using all spikes (solid line, y(x)=0.94x+0.03, R^2 = 0.81) or isolated spikes (dashed line, y(x)=1.04x-0.05, R^2 = 0.92).

Supplementary Figure 2. *The effect of low-threshold voltage-gated K^+ conductance on frequency tuning.* Previous reports have shown that expression of low-threshold voltage-gated potassium conductance (G_{Klt}) in NL varies across the tonotopic axis (Kuba et al., 2005). The effect of G_{Klt} on intrinsic frequency tuning in middle-CF NL neurons was tested by bath application of α-dendrotoxin (DTX; 100 nM; Alomone Labs). DTX blocks Kv1.1, 1.2, and 1.6 ion channel subunits and eliminates G_{klt} in NL neurons (Harvey and Robertson, 2004; Kuba et al., 2005). Before noise stimulation, neurons were held at approximately -46 mV using holding current. A zero-mean noise stimulus was then added, scaling the noise for each neuron to produce an average firing rate of 5-30 Hz. The holding current and stimulus scale were adjusted before and during α-dendrotoxin application to maintain a similar average membrane potential and firing rate despite the large increase in input resistance that occurs when low-threshold K^+ channels are blocked.

Legend

(**a**) The average STA current versus time relative to each isolated spike for a population of middle-CF neurons under control (black, n=12) and during bath application of DTX (gray, n=4). DTX application reduced the STA amplitude and slowed its time course. These effects on the STA have been observed previously in other classes of auditory brainstem neurons (Svirskis et al., 2004; Slee et al., 2005). (**b**) Frequency-dependent gain computed from the STAs in **a**. The inset shows the same data on logarithmic axes and over the entire frequency range represented in NL. The gain functions during DTX application showed a significant decrease in both the peak frequency (83+/-5 Hz) and gain half width (264+/-20 Hz) compared with middle-CF neurons under control conditions (308+/-6 Hz and 635+/-12 Hz). In addition, the peak gain in DTX in 3 of 4 neurons (1214, 1268, 609, 309 Hz/nA) was higher than the average of control neurons

(360+/-64 Hz/nA). This result suggests that G_{Klt} decreases gain at low frequencies but has only a small effect on gain at high frequencies.

Supplemental References

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