Supporting Information

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SI Materials and Methods

We created a model of cross-correlator neurons with mismatched spectrotemporal inputs from the left and right ears to have best interaural time differences (ITDs) that follow the frequency-dependent relationship observed in mammals (1). The gamma-chirp filter parameters were adjusted on each side so that the best frequency (BF) is matched between the left and right inputs, and the best ITD of the cross-correlator neuron matched the data shown in figure 2 of McAlpine et al. (1).

At a given BF, the gammachirp filters on the left and right sides were specified by finding values for the time constant τ, the in-stantaneous frequency (IF) glide slope c, and the instantaneous frequency at the initial time f_0. The time constant at a particular BF was given by $\tau = 1.3(\text{BF}/0.456 + 0.8)^{-2.585} + 0.4(\text{BF}/0.456 + 0.8)^{-0.3447}$, as measured for mammalian auditory nerve fibers (2). IF glide slopes were selected by hand from the range measured in the mammalian auditory nerve (3) to produce the desired best ITD. The instantaneous frequencies at the initial time were set as $f_0 = \text{BF} - \pi c \tau$ to force the BFs to be equal on the left and right sides. In several cases, the f_0 was modified slightly by hand from this value to achieve the desired BF.

1. McAlpine D, Jiang D, Palmer AR (2001) A neural code for low-frequency sound localization in mammals. *Nat Neurosci* 4:396–401.
2. Carney LH, Yin TC (1988) Temporal coding of resonances by low-frequency auditory nerve fibers: Single-fiber responses and a population model. *J Neurophysiol* 60:1653–1677.
3. Carney LH, McDuffy MJ, Shekhter I (1999) Frequency glides in the impulse responses of auditory-nerve fibers. *J Acoust Soc Am* 105:2384–2391.
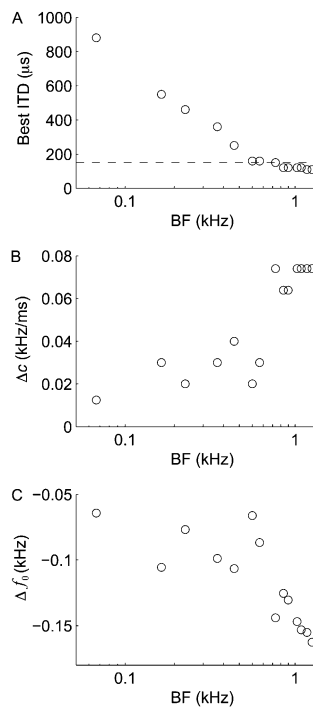
Fig. S1. Frequency-dependent best ITD produced by mismatching of spectrotemporal inputs. It is possible to produce the frequency dependence of best ITD seen in mammals (*A*) using a cross-correlation model where interaural differences in the IF glides change with frequency. The gammachirp filter parameters *c* (*B*) and f_0 (*C*) are adjusted on each side so that the best frequency is matched between the left and right inputs.