

Supplementary Information

A mechanoelectrical mechanism for detection of sound envelopes in the hearing organ

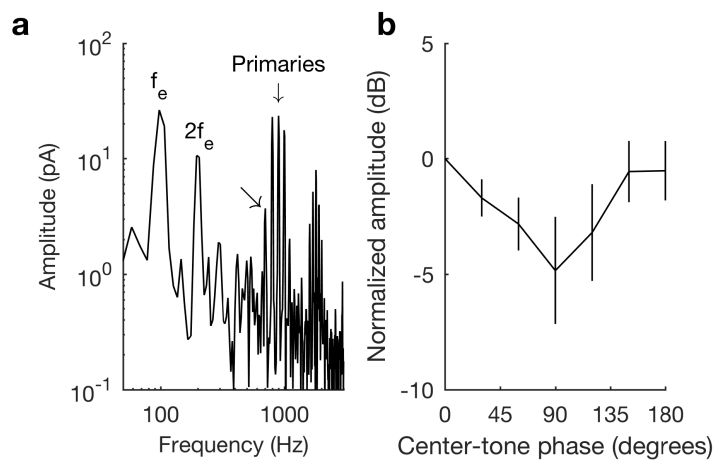
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Supplementary Note

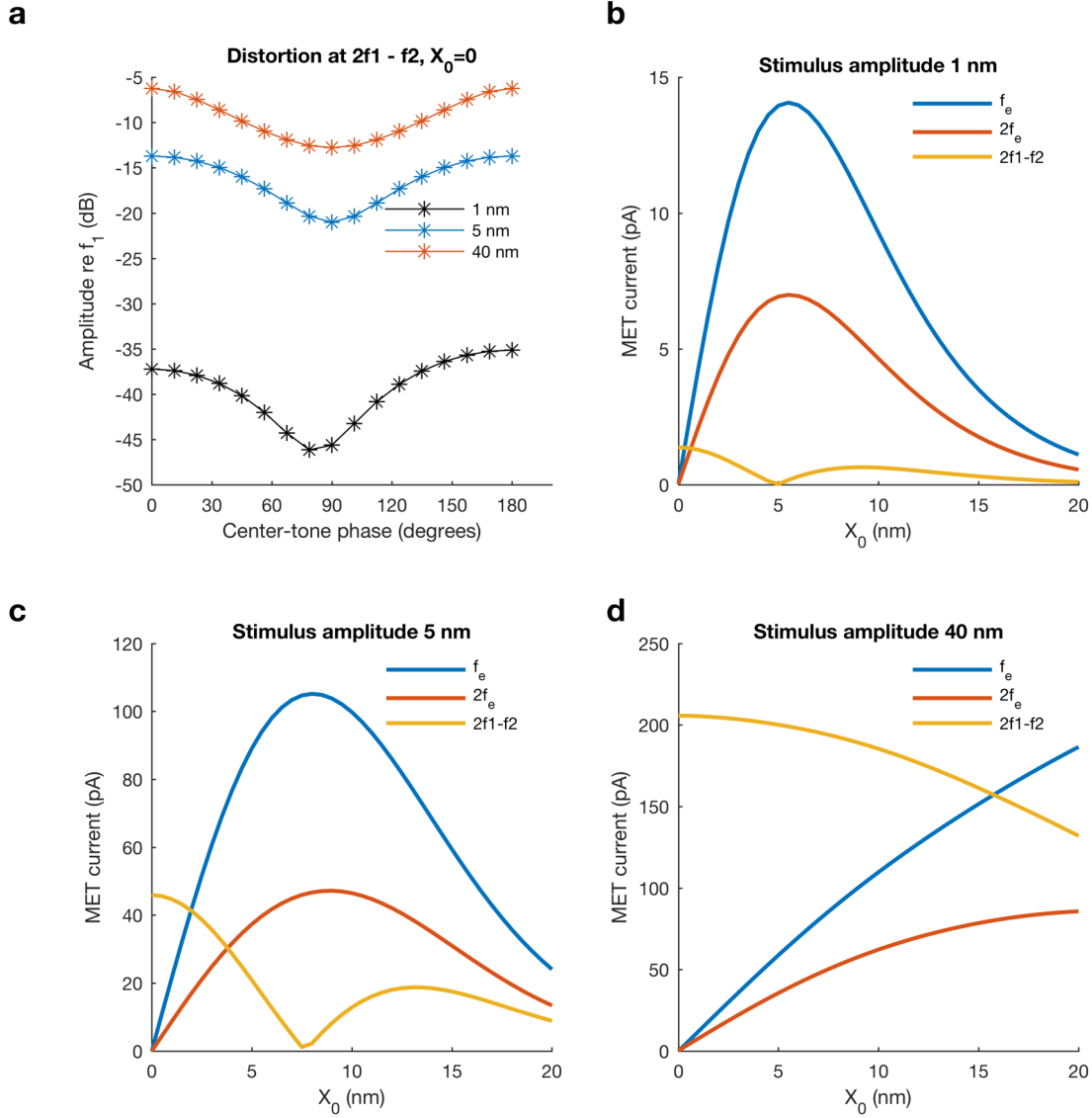
The effects of the envelope on the current through the MET channels is described in Fig. 7 in the main text. However, the spectra of the currents revealed an additional peak at $2f_1$ - f_2 (oblique arrow in Suppl. Fig. 1a). The amplitude of this peak changed as the envelope moved from a “peaky” shape to a flatter one (Suppl. Fig. 1b shows how the amplitude at $2f_1$ - f_2 depended on the center-tone phase). Note that the current tends to be smaller for center-tone phase 90° . Measurements parameters were the same as in Fig. 7.

These data prompted a study of the $2f_1$ - f_2 spectral peak in the model described in the main text (Fig. 7e – g). For 1-nm stimuli, the amplitude of the $2f_1$ - f_2 peak was around 40 dB below the amplitude of f_1 (Suppl. Fig. 2a). For larger stimuli, the amplitude at $2f_1$ - f_2 increased but the dip near center-tone phase 90° remained. Hence, the model reproduced aspects of the finding shown in Suppl. Fig. 1b.

In the model, we also studied how the amplitude of different distortion products varied with stimulus level and bundle resting position (X_0). For non-saturating stimuli, distortion at f_e and $2f_e$ was maximal for values of X_0 ranging from 5 to 10 nm (Suppl. Fig. 2b and c). At this bundle offset, distortion at the frequency $2f_1$ - f_2 was minimal. For stimuli large enough to saturate the MET current, the behaviour was however qualitatively different (Suppl. Fig. 2d). For such stimuli, the $2f_1$ - f_2 peak showed no minimum and the f_e and $2f_e$ peaks grew with increasing X_0 .



Suppl. Fig. 1. Distortion in patch-clamp recordings. **a.** Example spectrum of the MET current in response to three-tone stimulation with center-tone phase 0° . Responses at f_e and $2f_e$ are described in the main text. Oblique arrow denotes the $2f_1$ - f_2 peak, the amplitude of which is shown in panel b. Holding potential, -84 mV. **b.** Normalized amplitude of the spectral peak at $2f_1$ - $f_2 \pm$ standard error of the mean across 9 cells. The average current for phase 0° was 4.9 ± 1.7 pA.



Suppl. Fig. 2. Distortion in transducer channel model. **a.** Relative level of the $2f_1 - f_2$ peak for different center-tone phases and stimulus levels. **b** and **c.** For 1-nm stimuli (**b**) and 5-nm stimuli (**c**), the f_e peak (blue line) was maximal near a minimum for the $2f_1 - f_2$ peak (yellow line). **d.** Qualitatively different behaviour for saturating stimuli. In all four graphs, model parameters are identical to those used in Fig. 7 of the main text. f_1 , frequency of the first primary tone, see also Eq. 1 in the main text; MET, mechano-electrical transducer.