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ABSTRACTS

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Auditory brainstem responses from apical portions of the cochlea evoked by a basilar membrane resonance induced by fast stimulus rates

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Background
Recording subcortical neural activity evoked by apical portions of the cochlea is a challenge using current electrophysiological approaches. The slowing travel time of the basilar membrane (BM) at apical regions, and the long 'ring'; time of low-frequency auditory filters leads to reduce neural synchronization and, consequently, smaller evoked brain potentials than at more basal regions of the cochlea. The objective of this study was to improve the recording of auditory brainstem responses (ABRs) evoked by neurons located at apical portions of the cochlea by generating a resonance in the BM displacement with short-duration stimuli presented at fast rates.

Methods
We generated a BM resonance at the 500-Hz characteristic frequency (c_f) using diotic presentation of 100000 auditory stimuli at 80 dBnHL, at a mean rate equal to the c_f. Since fast stimulus rates lead to overlapping ABR signals, obtaining transient ABRs required (a) a presentation rate with a certain jitter [rather than using a fixed stimulus rate], and (b) deconvolution of overlapping responses. The auditory stimulus consisted of one period of a sinusoidal signal of frequency equal to the c_f and phase $+\pi/4$, windowed with a Blackman window of the same duration. Deconvolution was achieved by the iterative randomized stimulation and averaging (IRSA) technique. This study evaluated deconvolved ABR signals obtained from stimulation sequences of different jitters. Simulations showed that a BM resonance would be generated by low-jittered stimulation sequences, and we hypothesized that this resonance would increase neural synchrony within an auditory filter.

Results
Our preliminary data in normal-hearing listeners indicate that our techniques for generating a low-frequency resonance in the apical end of the cochlea generates, following the deconvolution process - the typical morphology of ABRs, with waves I, III and V clearly present in most of the conditions. Further, ABR components showed longer latencies than standard ABRs evoked by clicks, consistent with the delays associated with the cochlear delay of the traveling wave. Finally, low-jittered stimulation sequences evoked ABR components of a larger amplitude, possibly as a result of an increased neural synchrony derived from the generated BM resonance.

Conclusions
The enhanced neural synchrony achieved by a BM resonance generated by short duration stimuli [only one period of a sinusoidal signal] presented at fast rates may have potential in the clinic to improve the recording of ABRs evoked by low-frequency stimuli, and opens a new perspective to study subcortical neural processes associated with binaural hearing.

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Effect of Contralateral Acoustic Stimulation Measured with ABR and ECoG in the Mongolian Gerbil

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Descending cholinergic innervation of the inner ear and the cochlear nucleus mediates the olivocochlear reflex, which reduces the sensitivity of the inner ear to sound stimulation and supposedly plays an important role during hearing in noise. The majority of lateral and medial olivocochlear neurons are excited by responses from the same ear they project their axons to, thus forming an ipsilateral feedback loop. However, lateral and medial olivocochlear neurons are to a certain degree also excited by acoustic stimulation of the ear contralateral to their projection target. The exact function of the contralateral olivocochlear contribution is debated.

We eventually want to exploit the contralateral olivocochlear connection experimentally to study descending cholinergic influences on monaural neurons in the AVCN in vivo. To this end we needed to show the effectiveness of contralateral acoustic stimulation in our experimental animal, the Mongolian gerbil. Given reports of inter-individual variability of contralateral olivocochlear function, we also wanted to establish a simple screening method which can be applied to every experimental animal prior to more complex experiments. By applying scalp auditory brainstem recordings (ABR) and electrocochleography (ECoG) close to the round window we panoramically recorded electrical responses to broadband ipsilateral stimuli of the inner ear, auditory nerve and auditory brainstem.

We compared responses to ipsilateral clicks (0.1ms duration, alternating polarity; 0-90dB SPL) with responses to ipsilateral clicks preceded by contralateral noise bursts (50ms, 70dB SPL rms, 0.2-20kHz bandpass fil-