Disruption of Balanced Cortical Inhibition by Acoustic Trauma

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Sensory deafferentation results in rapid shifts in the receptive fields of cortical neurons, but the synaptic mechanisms underlying this plasticity remain unknown. The rapidity of these changes has led to the suggestion that subthreshold inputs may be unmasked by a selective loss of inhibition. We used in vivo whole cell recordings to directly measure tone-evoked excitatory and inhibitory synaptic inputs in auditory cortical neurons before and after acoustic trauma. Here we report that acute acoustic trauma disrupted the balance of excitation and inhibition by selectively increasing and reducing the strength of inhibition at different positions within the receptive field. These changes led to an expansion of receptive fields and a disruption of temporal precision. These results suggest that the synaptic mechanisms underlying cortical receptive field shifts include changes within the auditory cortex as well as at subcortical levels. These effects, which occurred for sounds of comparable intensity to those delivered by an iPod at maximum volume, may help to explain how noise-induced hearing loss can result in the phantom ringing in the ears known as tinnitus.