Sound-induced motion of outer hair cells: new observations and implications for the mechanisms of dynamic range compression

Marcel Van Der Heijden*†[1]

[1]Erasmus MC – Netherlands

Abstract

In the cochlea, mechano-electrical transduction by inner hair cells is preceded by a stage of dynamic range compression. A ˜90-dB range of sound intensities is compressed to ˜30 dB of intracochlear vibration magnitude to fit the limited dynamic range of transduction by inner hair cells. Outer hair cells (OHCs) and their voltage dependent length changes, known as electromotility, play a central role in this compression process, but the exact mechanisms are poorly understood. Here we review old and report new experimental findings, and show that (1) just audible high-frequency tones evoke an ˜1-microvolt AC receptor in basal OHCs; (2) any mechanical amplification of soft high-frequency tones by OHC motility would have an adverse effect on their audibility; (3) having a higher basolateral K+ conductance, while increasing the OHC corner frequency, does not boost the magnitude of the high-frequency AC receptor potential; (4) OHC receptor currents display a substantial rectified (DC) component; (5) mechanical DC responses (baseline shifts) to acoustic stimuli, while insignificant on the basilar membrane, can be comparable in magnitude to AC responses when recorded in the organ of Corti, both in the apex and the base. In the basal turn, the DC component may even exceed the AC component, lending support to Dallos' suggestion that both apical and basal OHCs display a significant degree of rectification. We further show that (6) low-intensity cochlear traveling waves, by virtue of their abrupt transition from fast to slow propagation, are well suited to transport high-frequency energy with minimal losses (˜2-dB loss for 16-kHz tones in the gerbil); (7) a 90-dB, 16-kHz tone, if transmitted without loss to its tonotopic place, would evoke a destructive displacement amplitude of 563 nm. We interpret these findings in a framework in which OHCs do not provide cycle-by-cycle feedback, but rather regulate local dissipation of intrachclear vibration by affecting the mechanical properties of adjacent structures in the organ of Corti.

*Speaker
†Corresponding author: marcel.vdh.work@gmail.com