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Inertial and cochlear constraints for high-frequency hearing in phocid and otariid pinnipeds

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In air-borne hearing, mammals rely on sound transmission through the tympanic membrane and middle ear ossicles between the surrounding air and the cochlea. The high-frequency hearing limit (HFHL) is determined by the ossicular inertia, and also by the cochlear sensitivity. Due to coevolution, the sensitivity ranges of the middle and inner ear structures generally overlap, and the roles of inertial and cochlear constraints for the HFHL are difficult to discern. For studying this question we considered anatomical and experimental data for two phocid and two otariid pinnipeds. While any detailed mechanism for pinniped underwater hearing remains unclear, an underwater HFHL exceeding that in air is possible. Published in-air and underwater audiograms provide an opportunity for comparing the roles of ossicular mass inertia and cochlear sensitivity in HFHL. Phocid ossicles are very heavy, and their inertia explains the lower HFHLs in air - according to underwater audiograms the phocid cochlea is sensitive to higher frequencies. Otariids have normal-sized mammalian ossicles, and their inertia should allow underwater hearing at higher frequencies than in air. However, the HFHL is approximately equal in air and water for otariids, hence their underwater HFHL is apparently set by the cochlea alone.