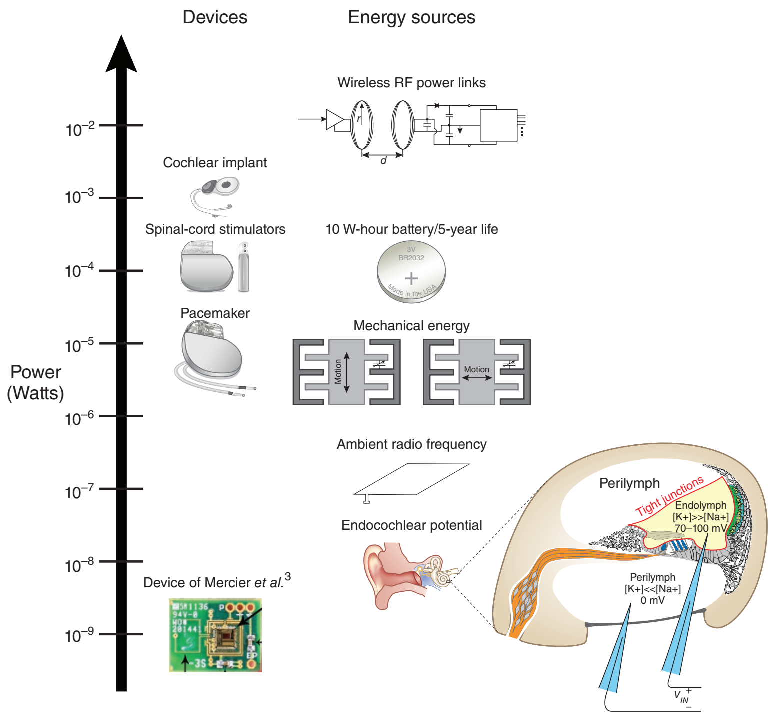

Figure 1 Commonly used biomedical devices with their power requirements (in Watts) and energy sources. The device described in Mercier *et al.*[3] is shown along with its energy source, the cochlear duct. Potassium ion secretion from the lateral wall of the cochlear duct generates a 70–100 mV electrochemical potential.

the study of hearing loss in humans and animals. Hearing and balance are compromised in hundreds of different human disorders[7]. Some of the most challenging to treat or rehabilitate are those in which hearing or balance function fluctuates. Ménière's disease, for example, is characterized by sudden and debilitating episodes of hearing loss, severe spinning dizziness, and fullness and ringing in the ear[8]. It has long been speculated that disorders such as Ménière's disease are caused directly or indirectly by fluctuations in endocochlear potential. This has never been proven, however, because the inner ear has been essentially a black box, particularly in live humans, where access is possible only by surgery that involves drilling through the temporal bone. The work of Mercier *et al.*[3] paves the way to direct understanding of the physiology of fluctuating hearing loss and balance in live, awake humans, and, we hope, to therapeutic interventions.

Several hurdles remain to be surmounted before the device of Mercier *et al.*[3] becomes a practical tool. The study highlights some of the challenges of the bioelectronic interface. First, the potentials involved are small, similar to the thermal voltage (kT/q) that determines the voltage scale for the modulation of current under the control of the gate in transistors. As a result, it is very difficult for CMOS integrated circuits to start up at low voltages. The authors rely on an alternate energy source—radio-frequency harvesting—for this startup. Second, electrophysiological energy sources rely on ions to carry charge, whereas integrated circuits rely on electrons. To convert ions to electrons requires an electrochemical interface that often (but not always, as in the case of redox intermediaries) consumes a chemical reagent when dc current is required, ultimately limiting the lifetime of the electrodes.

The electrodes are also susceptible to other degradation mechanisms that limit their stability. Stability may become a bigger issue with awake and moving recipient animals, although the high density and stability of the temporal bone may be beneficial in this respect. It will also be useful to adapt the device for use in mice, a common animal-model in auditory and vestibular research.

In considering the future potential of the work of Mercier *et al.*[3], it is worth recalling the history of the cochlear implant[9], a revolutionary neural prosthesis that has restored auditory perception, speech and language in >200,000 people worldwide. When the concept of the cochlear implant was first introduced, very few believed that it would work[10]. Mercier *et al.*[3] have given us a reason to believe that the future is bright for harnessing the body's own energy to monitor, heal and hear.

COMPETING FINANCIAL INTERESTS
The authors declare no competing financial interests.

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