the basal nerves and the bass increasing the apical-nerve activity.

But in the absence of sound, the afferent nerve fibres are not silent, because IHCs continue to release low levels of glutamate, triggering spontaneous action potentials. In mature animals, this spontaneous activity can range from less than 1 Hz to more than 150 Hz in different afferent fibres, allowing upwards or downwards modulation of the firing rates. With so much electrical activity, it is not surprising that the auditory centres have the highest cellular metabolic rates in the brain.

It had been considered that, before the onset of hearing in an animal, which is thought to coincide with the opening of the auditory canal (in rats and mice, at around 11–12 days after birth), spontaneous activity substituted for sound-evoked activity. If spontaneous activity occurred randomly, it would be less likely to trigger experience-dependent adaptive processes. But in the immature animal it is clustered[5], and this is consistent with the periodic activation of groups of afferent fibres by some unknown mechanism in the absence of sound input.

Tritsch *et al.*[3] have found that this early spontaneous activity originates from non-neuronal support cells in a transient structure of unknown function called Kölliker's organ located adjacent to the IHCs and running the length of the organ of Corti (see Fig. 1a on page 51). These cells release the chemical messenger ATP, which spreads locally, binding to P2X and P2Y receptors on adjacent cells and cascading onto the IHCs and their afferent fibres (Fig. 1b). The authors' finding that ATP release does not occur through the conventional calcium-mediated secretory pathway, but instead seems to be mediated by 'gap junctions', is important. Gap junctions usually allow small molecules, such as potassium, calcium and ATP, to pass between cells, so they might also allow ATP out of the support cells. Mutations in proteins that form these gap junctions (such as connexin 26 and connexin 30) are linked with the most common types of congenital deafness[6]. It will therefore be interesting to see whether these mutations affect the function of Kölliker's organ.

Tritsch and colleagues carry out recordings from single cells and non-invasive optical recordings from Kölliker's organ to show both spontaneous activity and raised intracellular calcium levels in clusters of cells along the organ of Corti. They then show how ATP release from the support cells excites local IHCs to release glutamate, which then triggers bursts of action potentials in auditory nerve fibres (Fig. 1b). The authors' achievement in recording directly from the very fine nerve fibres in contact with the base of the IHCs, and showing how the fibres are excited, is an impressive feat of cellular physiology.

So what do these results mean for our understanding of hearing? A prerequisite for experience-dependent adaptation is that the spontaneous activity should be elicited in a coherent or simultaneous manner, thereby defining a related population of nerve fibres. The observed synchronized activity in IHCs across a distance of around 60 micrometres, or 6–10 IHCs (and desynchronization between more distant IHCs), supports the idea that this activity may have a signalling function in defining the association between adjacent regions of the organ of Corti (tonotopy). Inevitably, this activity would cascade onto each subsequent higher level of auditory processing, moulding the development of the central auditory pathways and refining connectivity between the nerve-cell junctions, or synapses[5].

This process is important because in sensory regions of the brain, the afferent nerve fibres and their contacts with their target neurons maintain a topographic relationship with the peripheral sense organ through chemoaffinity mechanisms, which involve guidance molecules, and experience-dependent refinement[2,5,7]. For example, a topographic representation of two-dimentional visual space on the retina (referred to as retinotopy) is maintained at higher levels of the visual pathway and serves to guide visual processing. In the cochlea, sound frequency is mapped along the single row of IHCs running the length of the organ of Corti, and this tonotopic map is preserved as the afferent fibres in contact with the IHCs grow into the brain. An important goal will be to explore the ways in which activity-dependent processes interact with the chemoaffinity and neurotrophic mechanisms in the developing auditory pathway.

The work of Tritsch *et al.* highlights the need to re-examine activity-dependent modulation in developing central auditory pathways at much earlier times than were previously thought relevant. These fundamental studies provide insights not only into the mechanisms underlying auditory development, but also into those involved in deafness, tinnitus and implant therapies. Indeed, tonotopy is the principle behind cochlear implants that directly stimulate the eighth-nerve fibres in a deaf person's cochlea, and it permits implant technology to be extended to the cochlear nucleus and midbrain in patients with degeneration of the auditory nerve itself. ■

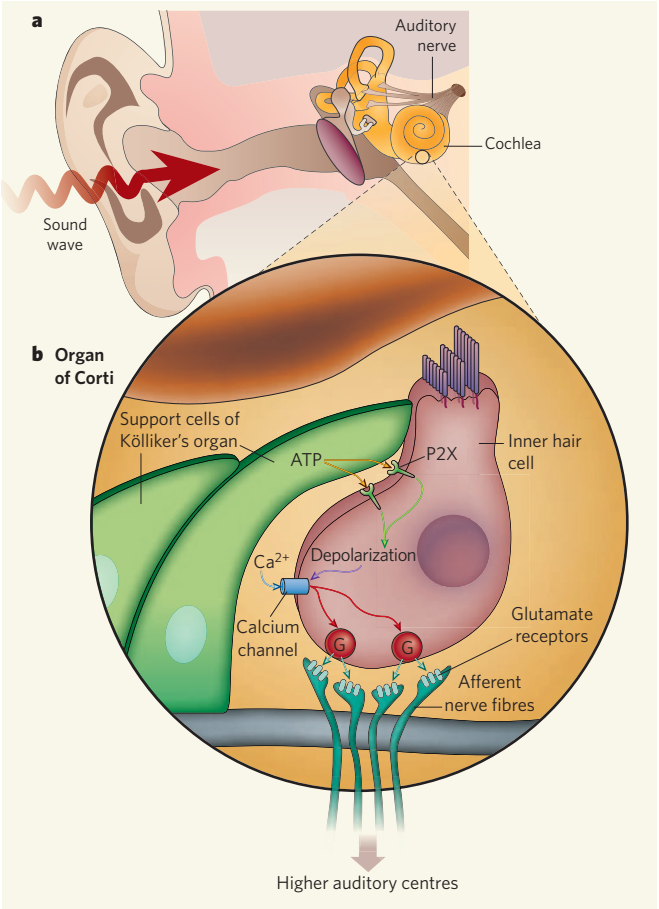

Figure 1 | Supporting the auditory pathway. a, After passing through the outer and middle ear, sound waves reach the cochlea in the inner ear. **b**, In the mature ear, sound vibration causes depolarization of the membrane of the inner hair cells. This opens voltage-gated calcium channels, allowing Ca^{2+} to flood into the cell to trigger release of the neurotransmitter glutamate. Tritsch *et al.*[3] find that, in the immature ear, Kölliker's organ releases ATP, which binds to P2X receptors on inner hair cells to cause depolarization and calcium influx, so mimicking the effect of sound input. In both cases, glutamate activates receptors on the afferent fibres, triggering electrical action potentials that propagate along the nerve fibres to the brain.

Ian D. Forsythe is at the MRC Toxicology Unit, Hodgkin Building, University of Leicester, Lancaster Road, Leicester LE1 9HN, UK.
e-mail: idf@le.ac.uk

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Correction
In the News & Views article "Linguistics: An invisible hand" by W. Tecumseh Fitch (*Nature* **449,** 665–667; 2007), artist's errors occurred in Figure 1, the glossogenetic tree of Indo-European language redrawn from a historical source. "Islamic" should read "Slavic". "Ukranian" should read "Ukrainian". And the branch leading to the Greek group of languages should likewise be labelled "Greek".