Autonomous and evoked Ca^{2+} activity of inner hair cells during the critical period of cochlear development

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Mammalian Inner hair cells (IHCs) transduce sound into receptor potentials and transmitter release. Together with supporting cells they form the organ of Corti. In the critical period of cochlear development, IHCs generate Ca^{2+} action potentials (AP) whereas ISCs produce Ca^{2+} waves. These Ca^{2+} signals are thought to drive intricate morphological and physiological changes. We performed Ca^{2+} imaging using acute mouse organs of Corti and the indicator Fluo-8 AM. IHCs showed two types of responses: They either autonomously generated fast Ca^{2+} transients, which depended on external Ca^{2+} and the expression of $Ca_v1.3$ channels and most likely reflect Ca^{2+} APs of IHCs. The more frequent type of IHC Ca^{2+} signals, however, consisted of slower and longer lasting burst-like Ca^{2+} elevations in neighbouring IHCs, which were triggered by Ca^{2+} waves in adjacent ICSs. The purinergic receptor antagonist PPADs blocked both ISC Ca^{2+} waves and the burst-like behavior of IHCs plus their synchronized activity, but not the fast IHC Ca^{2+} transients. Taken together, we show that IHCs Ca^{2+} signals are either triggered by Ca^{2+} waves of adjacent ICSs or are generated autonomously. Activation of immature adjacent IHCs by ISC Ca^{2+} waves may help to build up tonotopic organization in auditory circuits before the advent of sensory information.

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