



Institut Pasteur



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Institut national  
de la santé et de la recherche médicale

Paris, October 9th, 2008

Press release

## Distorting sounds for improved hearing

*How research into hereditary deafness has revealed the way in which the inner ear distorts sounds*

**A study carried out by researchers from the Institut Pasteur and Inserm, published in the journal *Nature*, has revealed how the inner ear distorts sounds. This distortion is one of the essential stages in the processing of sound by the ear, before this sound is encoded so that it can be transmitted to the brain in the form of an electrical signal. This breakthrough should help to improve the interpretation of a number of existing audiological tests.**

The auditory sensory cells within the inner ear carry out complex sound processing before this sound is encoded in the form of electrical messages sent to the brain. The sound is amplified and filtered, noise is removed, and the various frequencies which make up the sound are strengthened or weakened by what are known as 'masking' mechanisms, which improve contrast. Contrary to hi-fi technology, sounds that have been processed in this way are considerably distorted, to such an extent that we can hear extra sounds that are absent from the initial acoustic message. Musicians are familiar with these distortions, which they call 'Tartini tones' after the Italian violinist and composer who first described them in the 18th century. In the medical field, these tones are particularly interesting as the ear re-emits them (this is why they are known as 'otoacoustic emissions') and they can be detected very easily. Otoacoustic emissions can be used to help detect deafness from birth, as their absence indicates that the cells that produce them are damaged.

It was previously thought that all these processes – amplification, filtering, noise removal and distortion – resulted from specific work carried out by inner ear molecules making up the 'transduction channels'; these channels transform sound vibrations into electrical messages, by conducting ionic currents at the rhythm of the sound. These transduction channels are found in the hair bundles of sensory cells which are made up of stereocilia connected by fibrous links.

The research published in *Nature* demonstrates that this is far from being the case. The findings are the result of a study carried out by the Institut Pasteur's Genetics and Physiology of Hearing team, Inserm unit UMRS 587 (also affiliated to the Collège de France and the University Pierre and Marie Curie), directed by Professor Christine Petit, in close cooperation with Professor Paul Avan from the University of Clermont-Ferrand and with the participation of a British team from Brighton led by Dr Guy Richardson. The Pasteur and British laboratories are part of a European consortium, EuroHear.

The researchers studied mice carrying a genetic mutation which is responsible for deafness in humans. These mice gradually became deaf. However, beforehand, they presented a very specific combination of auditory characteristics. They were capable of amplifying sound and filtering it normally. They therefore had normal transduction channels, yet they did not distort sound waves. These mice were lacking in certain links connecting hair-bundle stereocilia. The loss of these links therefore prevented them from distorting sounds, and when faced with a mixture of sounds, they were not able to extract the most important sound components.

In order to hear well, it is not enough merely to have sensitive hearing; the sense of hearing needs to remain effective in noise or when faced with mixtures of sounds. In order for auditory centers to extract the meaning of the messages received, these messages must arrive having been correctly sorted by the inner ear. The identification of a component in the mechanism that improves contrast in noise therefore represents a significant contribution towards a deeper understanding of this mechanism, which is essential to oral communication. It should also enable the improved interpretation of a number of audiological tests.

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## **Source:**

**“Stereocilin-deficient mice reveal the origin of cochlear waveform distortions”:** *Nature*, advanced publication online: October 8, 2008.

Elisabeth Verpy<sup>1,2,3,4</sup>, Dominique Weil<sup>1,2,3,4\*</sup>, Michel Leibovici<sup>1,2,3,4\*</sup>, Richard J. Goodyear<sup>5</sup>, Ghislaine Hamard<sup>6</sup>, Carine Houdon<sup>1,2,3,4</sup>, Gaëlle M. Lefèvre<sup>1,2,3,4</sup>, Jean-Pierre Hardelin<sup>1,2,3,4</sup>, Guy P. Richardson<sup>5</sup>, Paul Avan<sup>7\*</sup> & Christine Petit<sup>1,2,3,4\*</sup>

1. Institut Pasteur, Genetics and Physiology of Hearing Unit, F75015 Paris, France.
2. Inserm UMRS 587, F75015 Paris, France.
3. Collège de France, F75015 Paris, France.
4. University Pierre and Marie Curie, F75015 Paris, France.
5. University of Sussex, School of Life Sciences, Falmer, Brighton BN1 9QG, UK.
6. Institut Cochin, Homologous Recombination Platform, F75014 Paris, France.
7. University of Auvergne, Laboratory of Sensory Biophysics, F63001 Clermont-Ferrand, France.

\* *These authors contributed equally to this research.*

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## **Contacts:**

- *Institut Pasteur Press Department:*

Corinne Jamma or Nadine Peyrolo – +33 (0)1 45 68 81 46 – [presse@pasteur.fr](mailto:presse@pasteur.fr)

- *Inserm Press Department:*

Séverine Ciancia – +33 (0)1 44 23 60 98 – [presse@inserm.fr](mailto:presse@inserm.fr)

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