William Demant Foundation

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Institute of Sound and Vibration Research

Using vibration on the wrists to enhance cochlear implant listening

Mark Fletcher

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MAKING CONNECTIONS

Rumours of Willetta

The deaf and blind girl who can:

- Read by feeling the ink on a page
- “Smell colour”
- Identify people by their odour
- **Feel sound**

Amazing Feats of 17-Year-Old Blind and Deaf Girl, Who Smells Colors and Feels Sound, Convince Scientists that Unused Powers Lie Asleep in Our Senses

CAN we learn to see with our noses? Can we learn to hear with our finger tips? Can we develop eyes in the backs of our heads or wherever else we happen to need them?

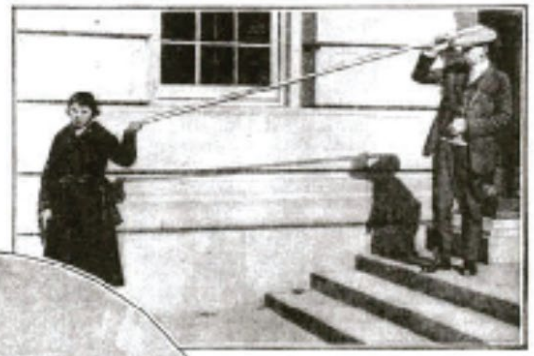
The amazing case of Willetta Huggins, the 17-year-old blind and deaf girl of Janesville, Wis., makes these questions much less fantastic than they would have seemed a year ago. For Willetta can do some of these things.

While we human beings have been developing to a high degree our senses of sight and hearing, have we failed to develop at the same rate our senses of smell and touch? The accomplishments of this little girl, handicapped from babyhood, seem to prove that this is so.

She Smells Color!

Willetta can recognize colors by their smell. She can hear spoken words by placing the sensitive tips of her fingers against the throat of the speaker. She can identify different people by their personal odors. *She knows, even, when the family cat enters the room for a moment and then leaves.*

Physicians and psychologists are still debating the exact nature and extent of Willetta's powers. Scientific tests of her case are still in progress. There seems little doubt, however, from the experiments made that she really does possess a remarkable development of the senses of smell and of touch.



Through her sensitive finger tips, this remarkable 17-year-old deaf-blind girl feels words as they vibrate down a long pole resting on the head of the speaker

Willetta Huggins, deaf and blind, hears the world of voices by placing her fingers on the receiver diaphragms of a telephone instrument. It is possible, scientists believe, that Willetta differs from the rest of us only in that she has learned how to use senses that we have neglected

was attracted in Chicago and on April 26, 1922, Willetta was examined before the Chicago Medical Society.

There is still some controversy about exactly what she can do, but the following facts are well attested:

She can recognize spoken sounds when her fingers are touching the throat of the speaker. She insists that she does not hear the sounds. She says that she "feels" them. She can also feel sounds in the same way through a wooden rod, such as a billiard cue, one end of which is pressed against the chest of the speaker, the other end of which she touches.

She carries around with her a portable telephone of the kind used by deaf people, but she does not put it to her ear. Instead, she touches the

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Rumours of Willetta

"I myself took the transmitter of Willetta's Portophone into a closet and closed the door upon the wire. I covered myself and the transmitter tightly with a heavy comforter. Willetta, outside the door, had her ears stopped with cork, and a heavy double woolen blanket was bound around her head and neck. Outside the blanket she held the receiver, with finger against the diaphragm. I recited seven short sentences and five questions into the transmitter. After each sentence or question was completed her blanket was raised and she repeated to the assistant what had been said with but a few unimportant variations. When, subsequently the assistant was bound up as Willetta had been, he could not hear my voice. ***I believe we have here a satisfactory demonstration that she interprets the human voice through vibrations against her fingers.***"

Robert Gault in 1922

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Robert Gault, Bell Labs & the amplification revolution

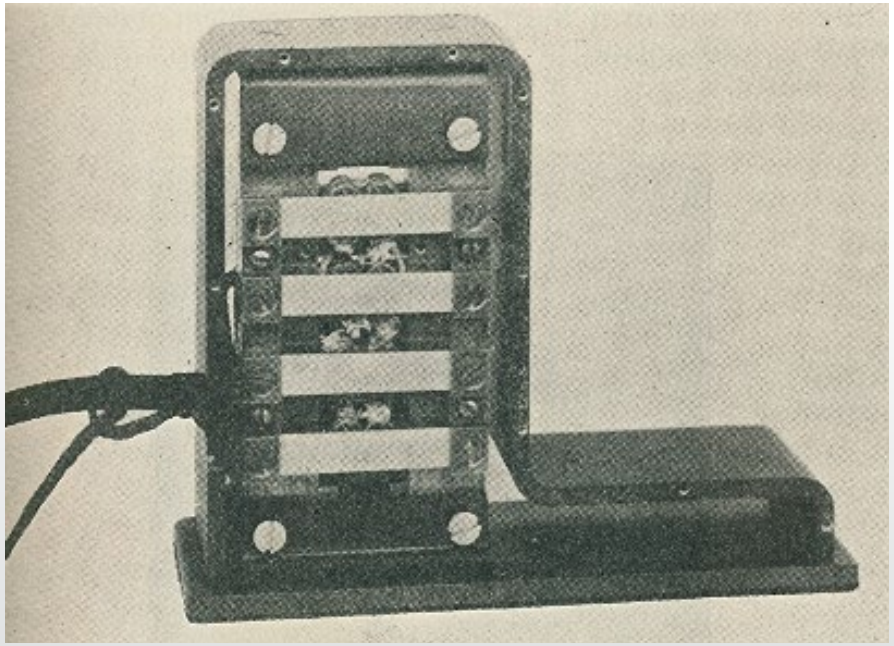
The Teletactor

The New York Times

DEVICE HELPS DEAF TO PLAY THE PIANO; Teletactor, Using Sense of Touch, Transfers by Vibrations Nuances Hitherto Unavailable. MANY WORDS UNDERSTOOD Northwestern University Professor, Inventor, Says It Makes "Meat" and "Beat" Distinguishable.

Special to THE NEW YORK TIMES.

April 24, 1932



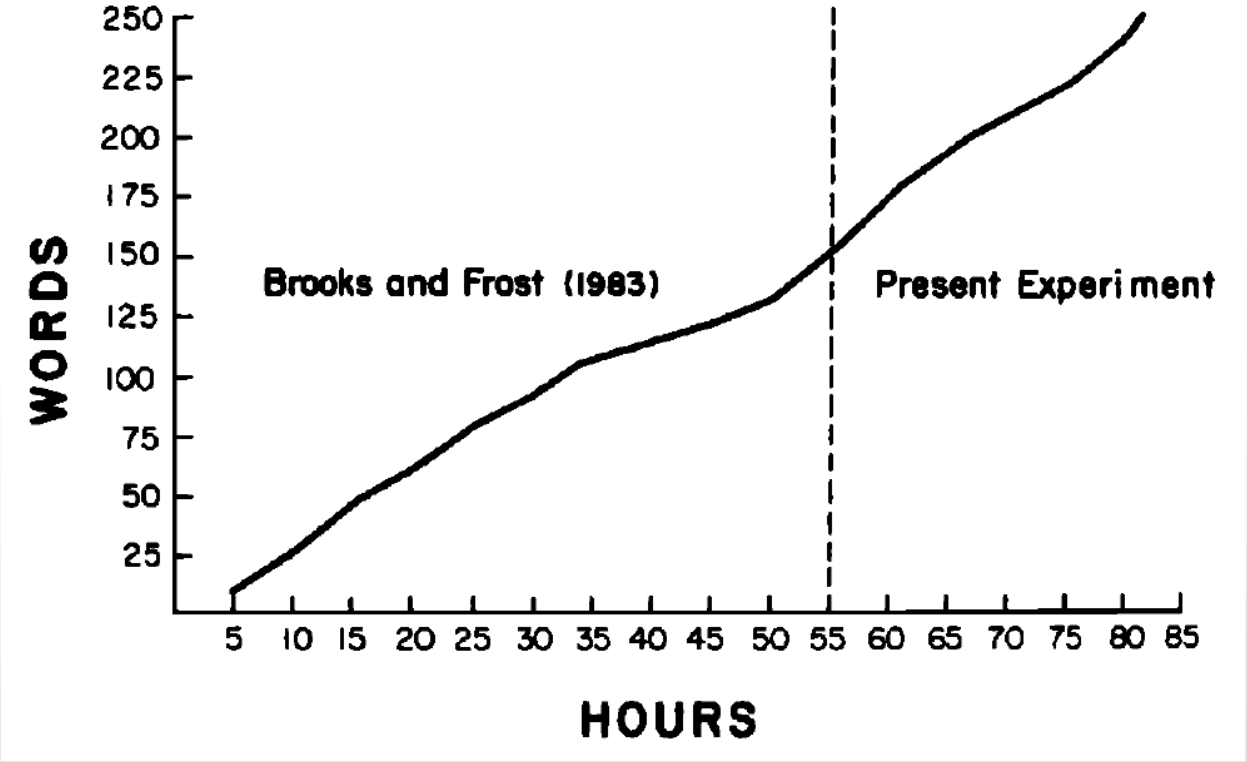
A loss of interest

- Widely held belief that very few people have total deafness (citing fact that almost all profoundly hearing-impaired people could detect low pitch sounds). The ultimate solution will more powerful hearing aids
  - ***What's going on here?***

Growth of interest in the 1970s and 1980s

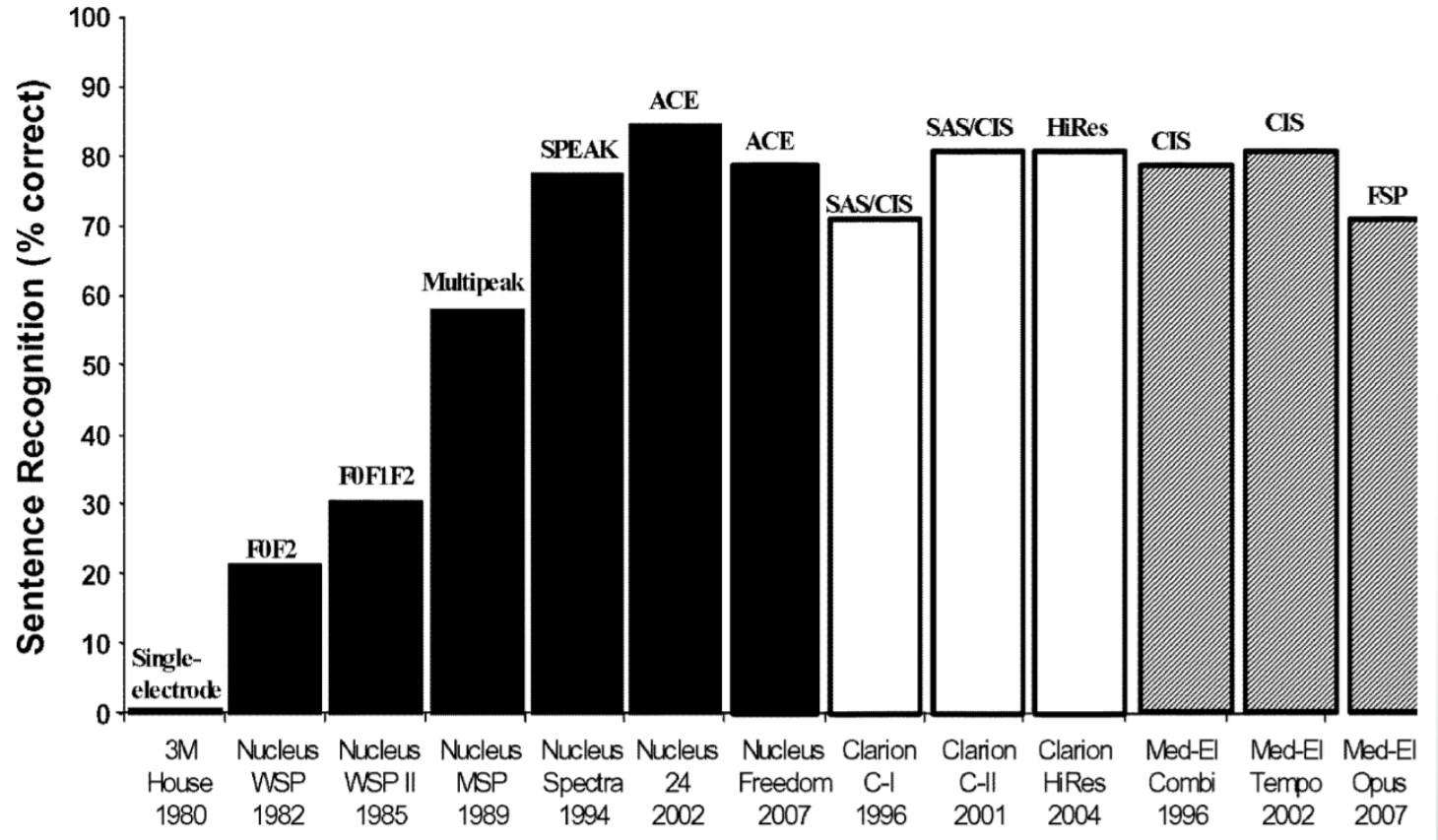
VS

Growth of interest in the 1970s and 1980s



Brooks et al (1985) Acquisition of a 250-word vocabulary through a tactile vocoder. J Acoust Soc Am.

Growth of interest in the 1970s and 1980s



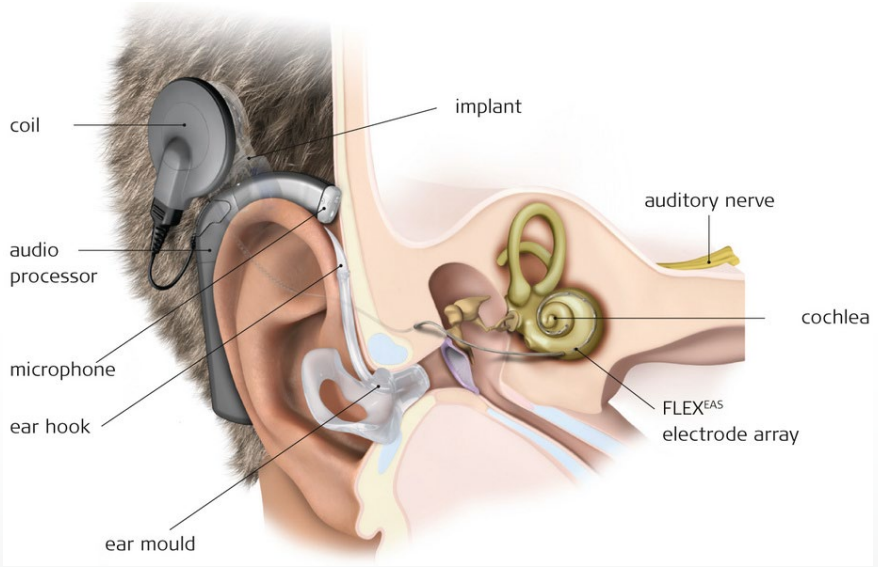
Zeng et al (2008) Cochlear Implants: System Design, Integration, and Evaluation. IEEE Rev. Bio. Eng.

Another loss of interest

VS

The challenge for cochlear implants

- The cochlear implant is the most successful sensory prosthesis, but has key limitations:
  - *Speech in noise*
  - *Spatial hearing*



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Another growth in interest?

VS

Another growth in interest?

+

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Our work

- Does it work for speech in noise?
- Does it work for spatial hearing?

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Our work

- **Does it work for speech in noise?**
- Does it work for spatial hearing?

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Speech in noise

Ama Hadeedi

Fletcher, M.D., Hadeedi, A., Goehring, T., & Mills, S.R. (2019) Electro-haptic enhancement of speech-in-noise performance in cochlear implant users. Nature Scientific Reports

Vinson Song

Fletcher, M.D., Song, H., & Perry, S.W. (2020) Electro-haptic stimulation enhances speech recognition in spatially separated noise for cochlear implant users. Nature Scientific Reports

The study:

- Haptic simulation on the wrist of CI users
- Algorithm for converting sound to vibration that can be used on a small device in the real world
- Test with realistic sounds

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The results:

- 10% more words recognised in noise on average
- Over 20% more words for some people

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Our work

- **Does it work for speech in noise?**
- Does it work for spatial hearing?

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Our work

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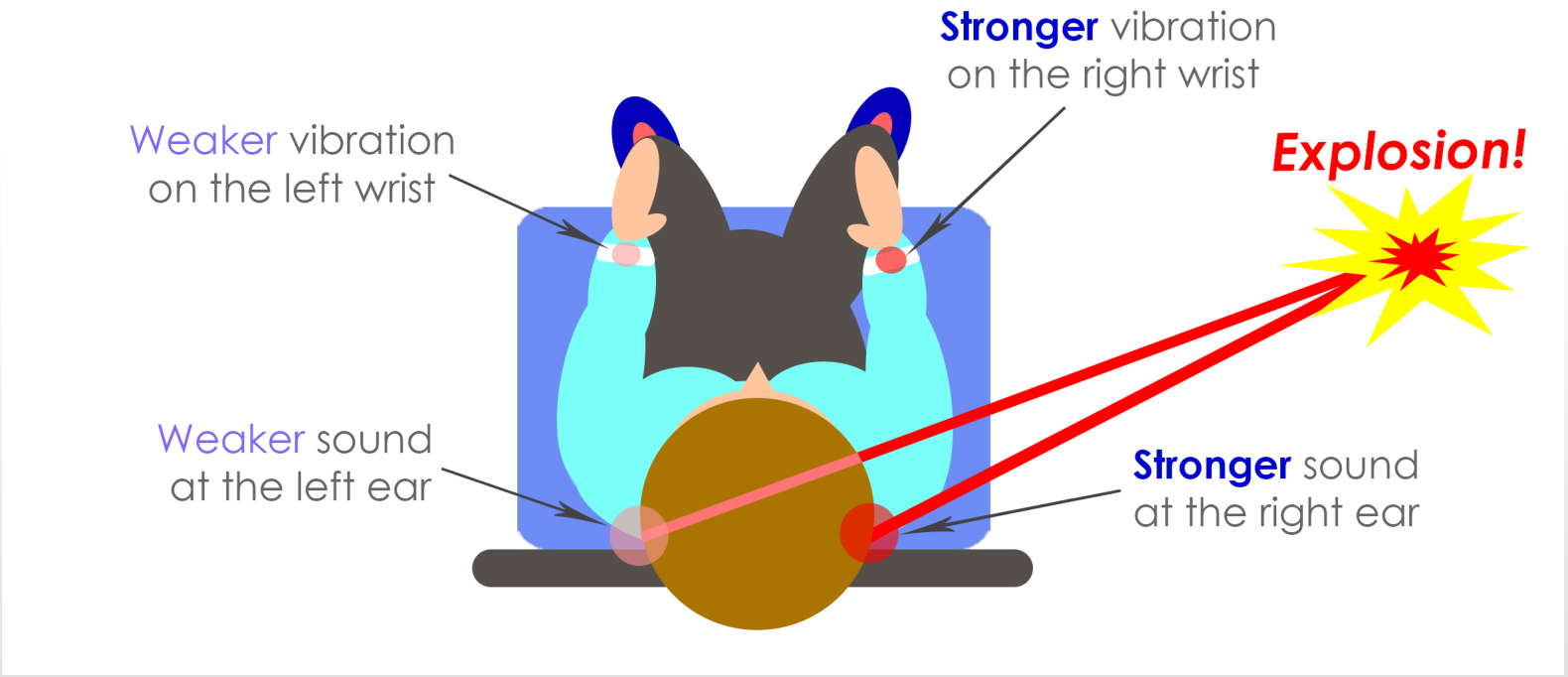
Spatial hearing

Spatial hearing

Sound to the right



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Spatial hearing

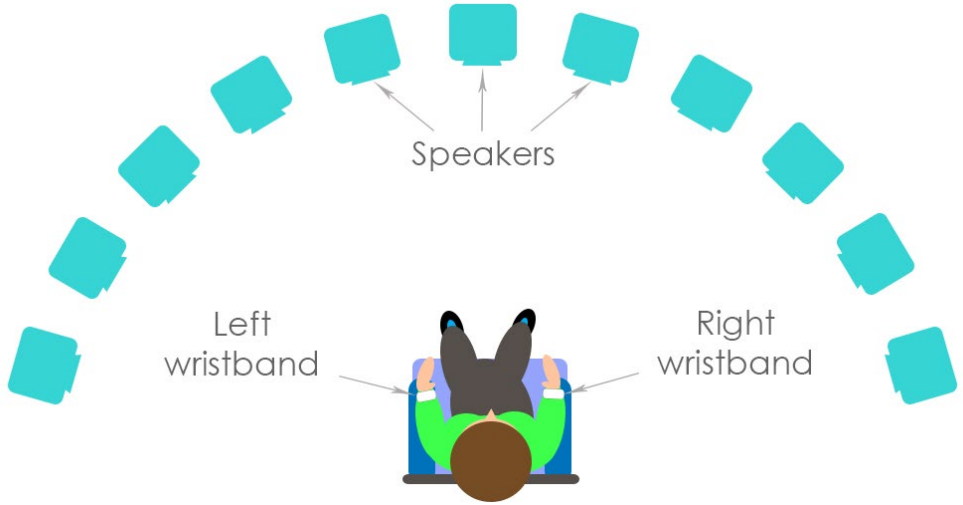
Robyn Cunningham

Fletcher, M.D., Cunningham, R.O., & Mills, S.R. (2020) Electro-haptic enhancement of spatial hearing in cochlear implant users. Nature Scientific Reports

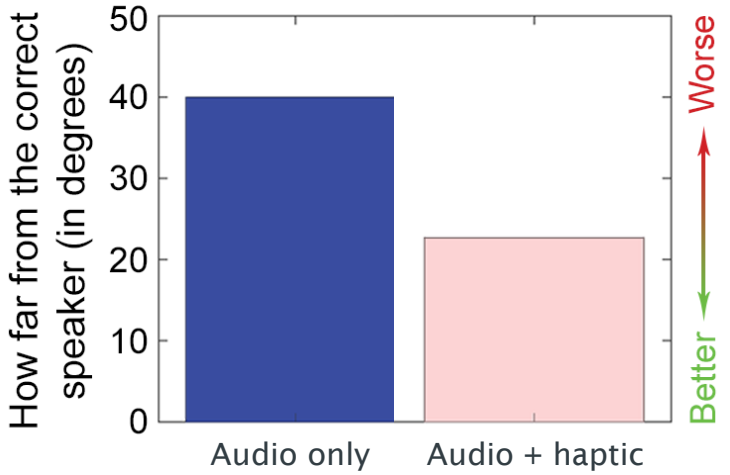
Jana Zgheib

Fletcher, M.D. & Zgheib, J. (2020) Haptic sound-localisation for use in cochlear implant and hearing-aid users. Nature Scientific Reports

Experiment set up



Results



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Our work

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Why does it work?

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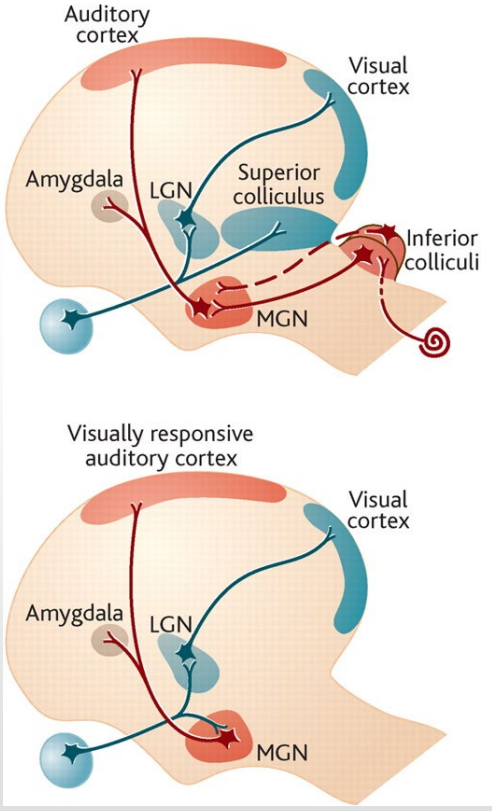
Why does it work?

The brain loves information and is extremely flexible.
It doesn't mind weird.

Why does it work?

The brain loves information and is extremely flexible. It doesn't mind weird.

- If you rewire the brain so visual input goes to the auditory cortex in baby ferrets, they are still able to "see"



Sur et al (1999) Rewiring Cortex: The Role of Patterned Activity in Development and Plasticity of Neocortical Circuits

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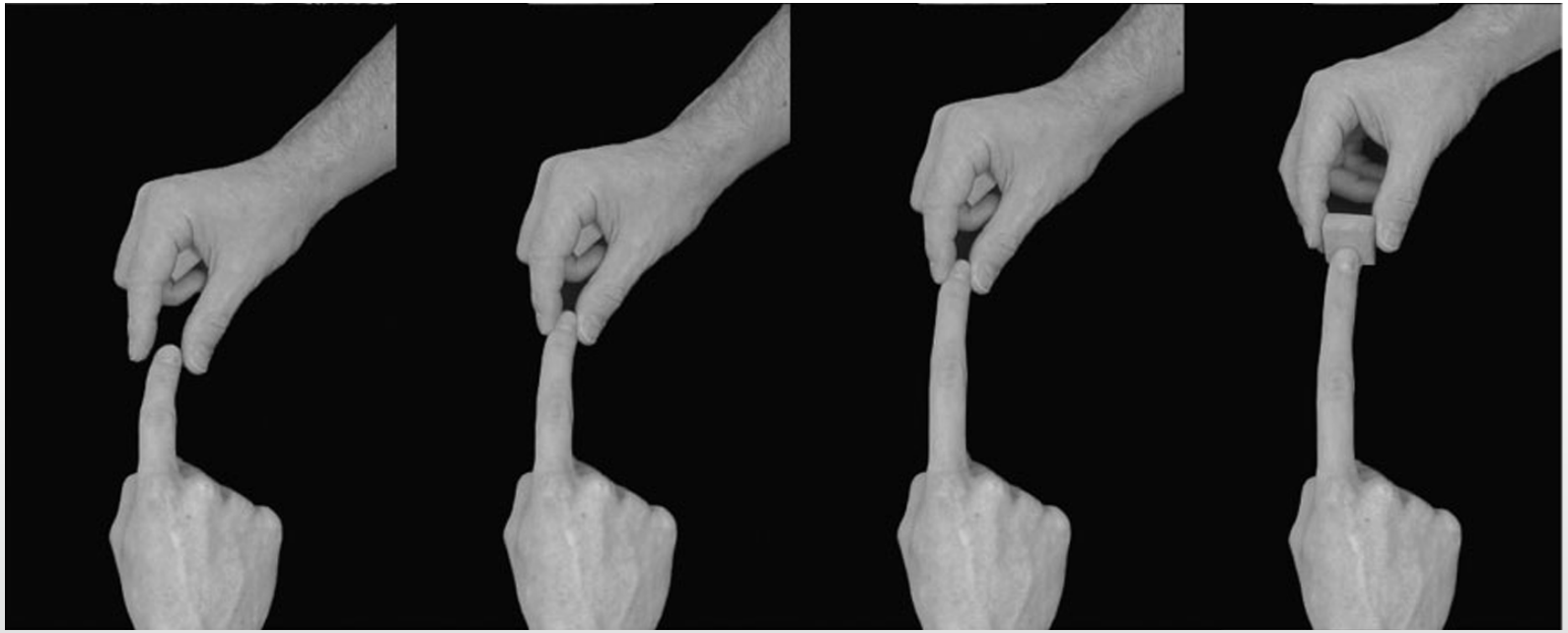

Rodger Newport, University of Nottingham

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The future of haptic aids for hearing

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The future of haptic aids for hearing

- Enhancing music perception
- Enhancing situational awareness

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The future of haptic aids for hearing

A device for CI users and those who can’t access CIs

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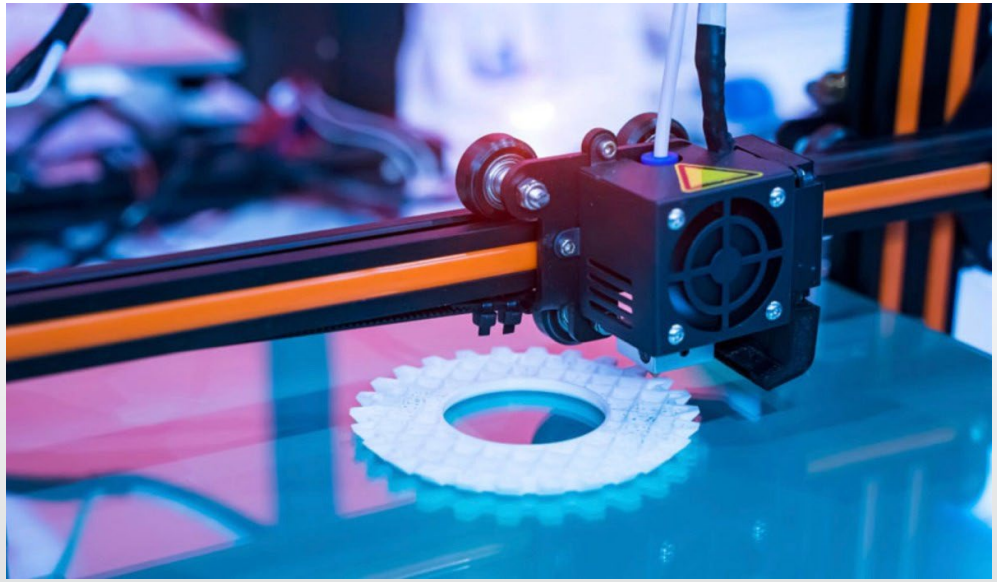
The future of haptic aids for hearing

A device for CI users and those who can't access CIs

- Key technologies have moved on massively since this was last seriously looked at in auditory science
  - *Compact haptic motors*
  - *Computer chips (microprocessors)*
  - *Advanced algorithms (e.g., AI)*
  - *Wireless technologies*
  - *Battery*
  - *Manufacturing (e.g., 3D printing)*



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The future of haptic aids for hearing

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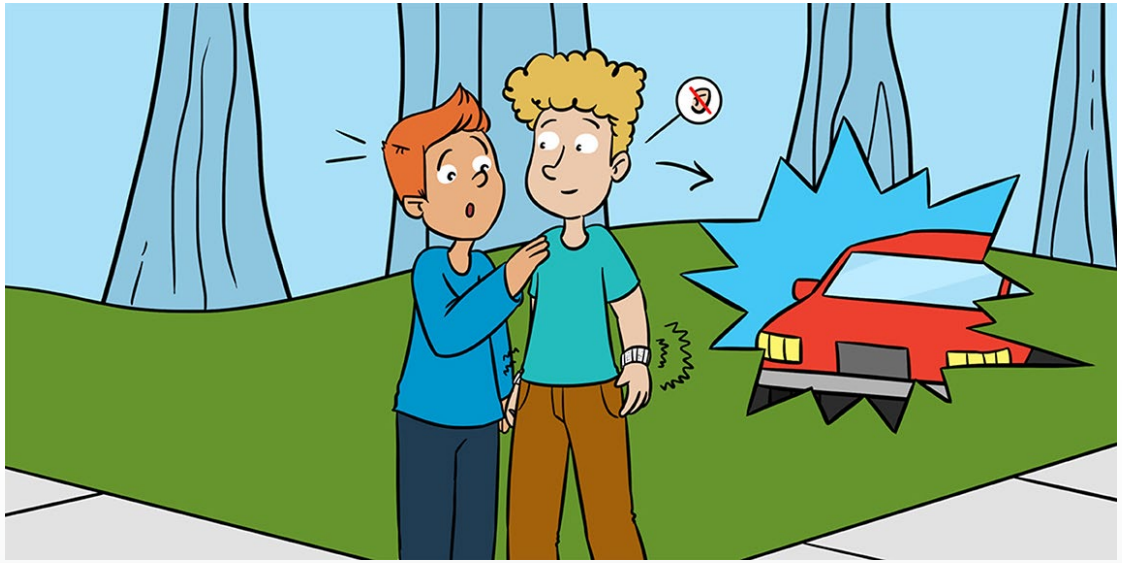
Thanks for listening



If you're interested in learning more…

Fletcher (2021) Listen with your wrists. *Frontiers for Young Minds*

Fletcher & Verschuur (2021) Electro-haptic stimulation: A new approach for improving cochlear-implant listening. *Frontiers in Neuroscience*

Electrohaptics.co.uk

M.D.Fletcher@soton.ac.uk