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# Seeing with Sound - The vOICe



Tucson, April 8, 2002

## Seeing with Sound for the Blind

### Is it Vision? Can it be?

Peter Meijer

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& [www.seeingwithsound.com](http://www.seeingwithsound.com)

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# Seeing with Sound - The vOICe

## Overview



- **Principles and Implementations**
  - *Crossmodal mapping & technical validation*
  - *Hardware and software implementations*
- **Examples of image-sounds**
- **Psychology and Philosophy**
  - *First-person perspectives (qualia)*
  - *The Molyneux problem revisited*
- **Neuroscience**
  - *Brain scans and crossmodal plasticity*
- **Future work and Conclusions**

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## The vOICe concept

**Basic facts:**

- Blind people cannot **see...**  
but usually they can **hear**
- Multimedia computing allows  
audio-visual transformations

## The vOICe concept

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**Basic facts:**

- Blind people cannot see... but usually they can hear
- Multimedia computing allows audio-visual transformations

**So translate video to audio!?**

**Crossmodal plasticity?**

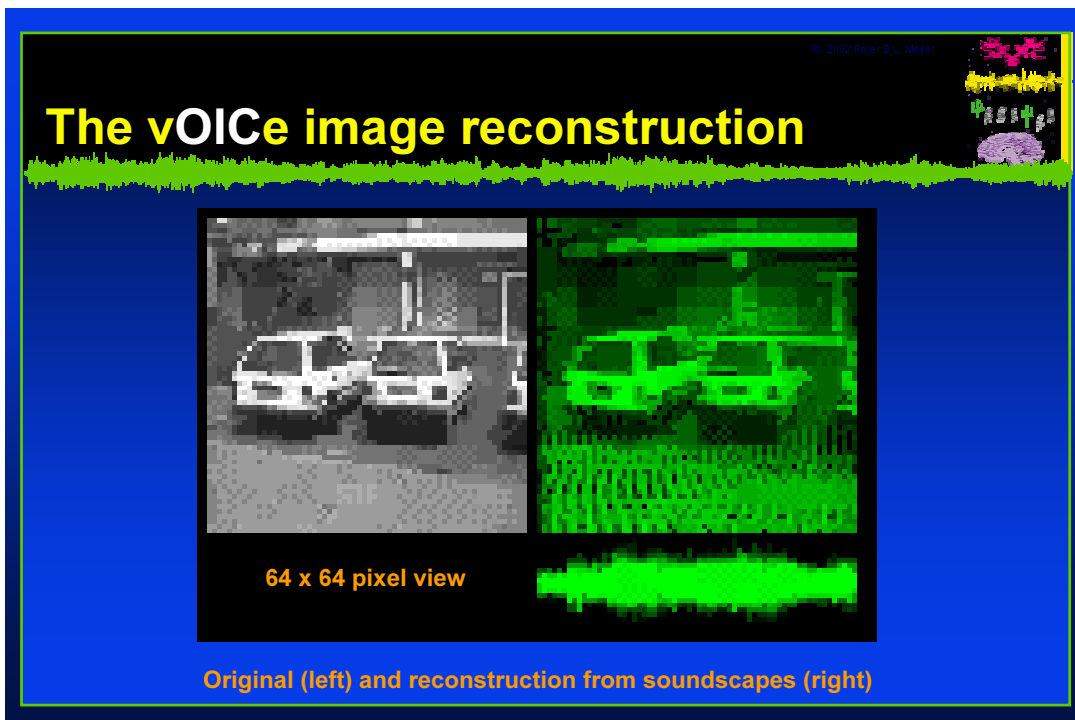
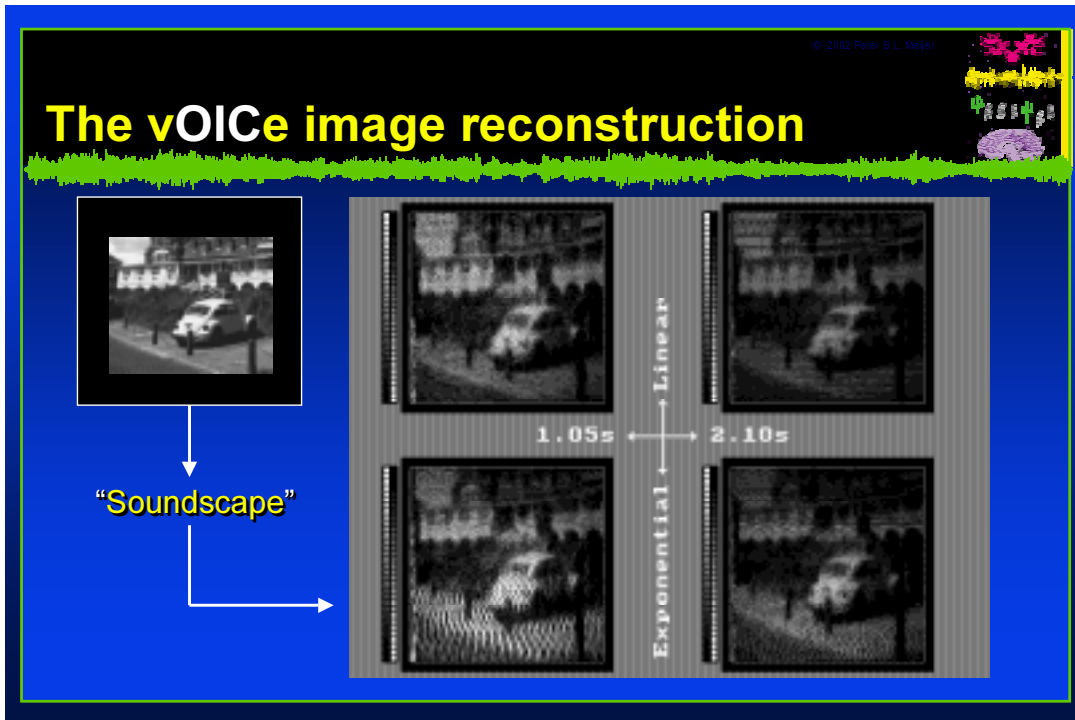
## The vOICe image-to-sound mapping

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Frequency

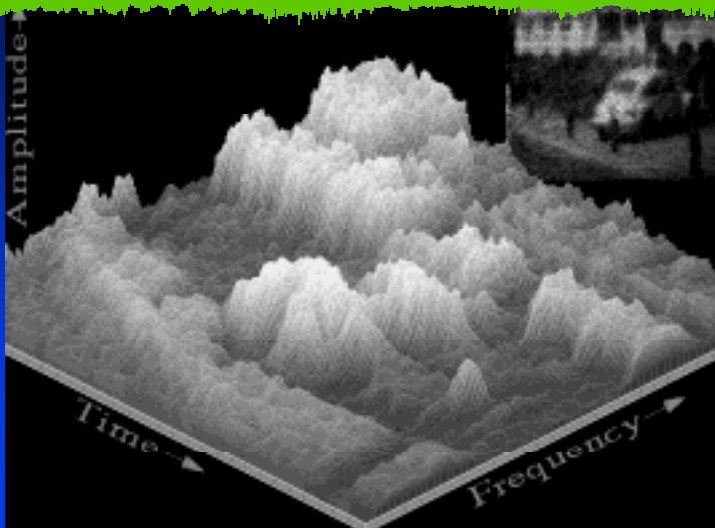
Spectrographic synthesis

Time



## The vOICe mental imagery?

**Warning:**  
Representation may dramatically affect recognition!



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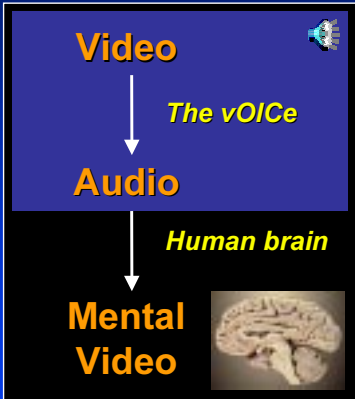
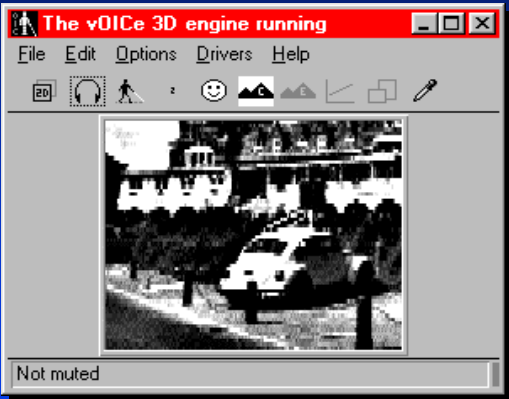
## The vOICe limitations?

**Issues:**

- ✓ Frequency-Time uncertainty
- **Physiology / Perception:**
  - ✓ just-noticeable difference (JND)
  - ✓ critical bands (human cochlea)
  - ? auditory streaming/segregation
  - ? neural pathways & bandwidth
  - ? neural processing & plasticity
- **Psychology / Education:**
  - ? sounds (too) unpleasant
  - ? minimum required results
  - ? acceptable training effort
  - ? motivation for learning
  - ? training programs

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## The vOICe Learning Edition software



Free download: [www.seeingwithsound.com/winvoice.htm](http://www.seeingwithsound.com/winvoice.htm)

## Wearing The vOICe

OIC? Oh I see!



- Video:** Hidden camera
- Processing:** Notebook PC
- Audio:** Stereo headphones

A fully immersive visual experience?



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## Seeing with Sound - The vOICe

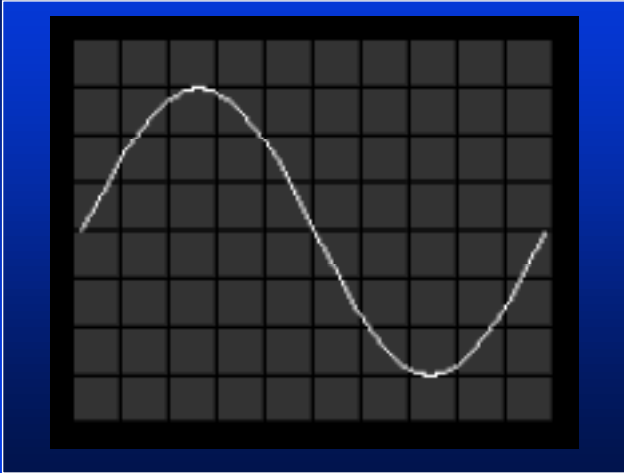


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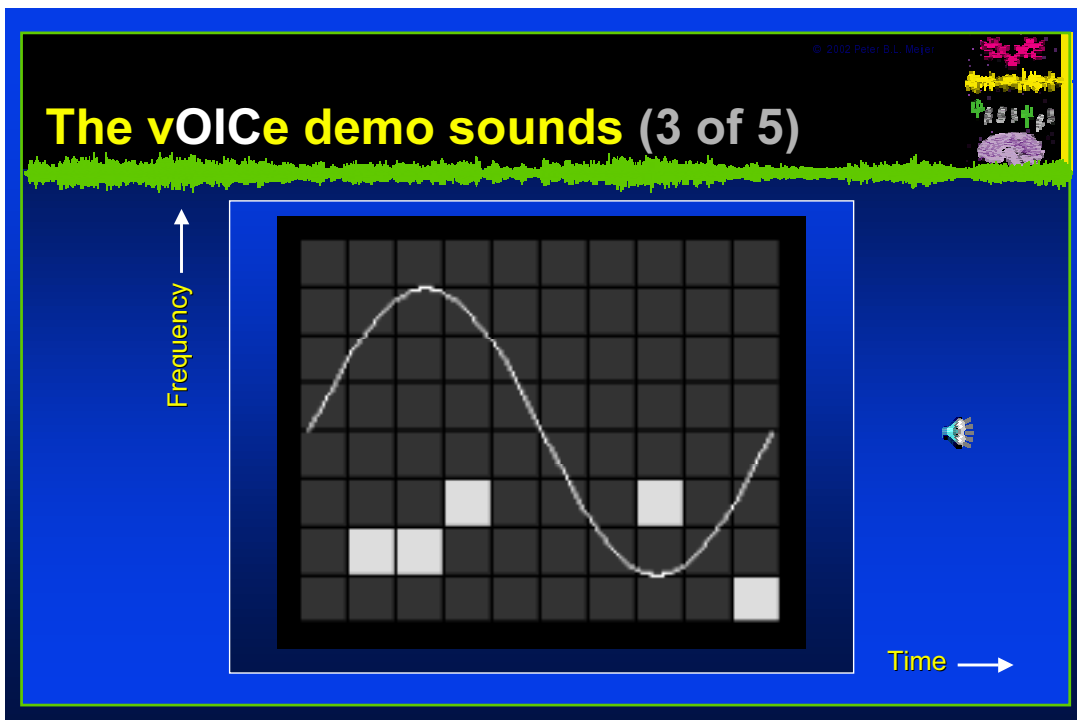
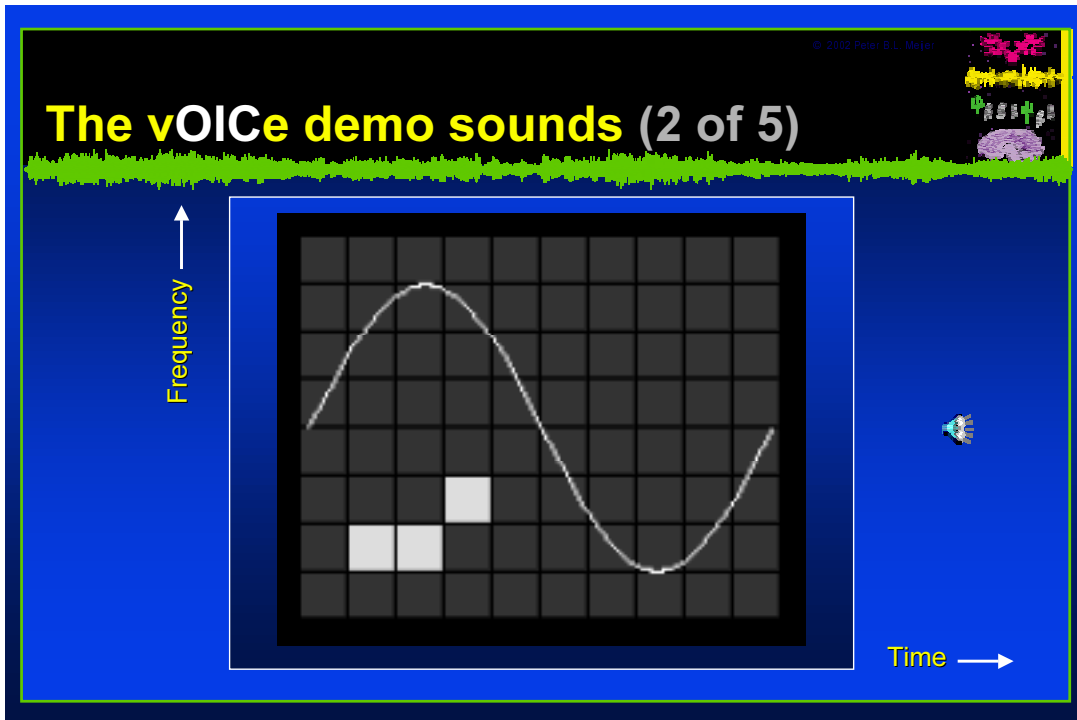
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## The vOICe demo sounds (1 of 5)

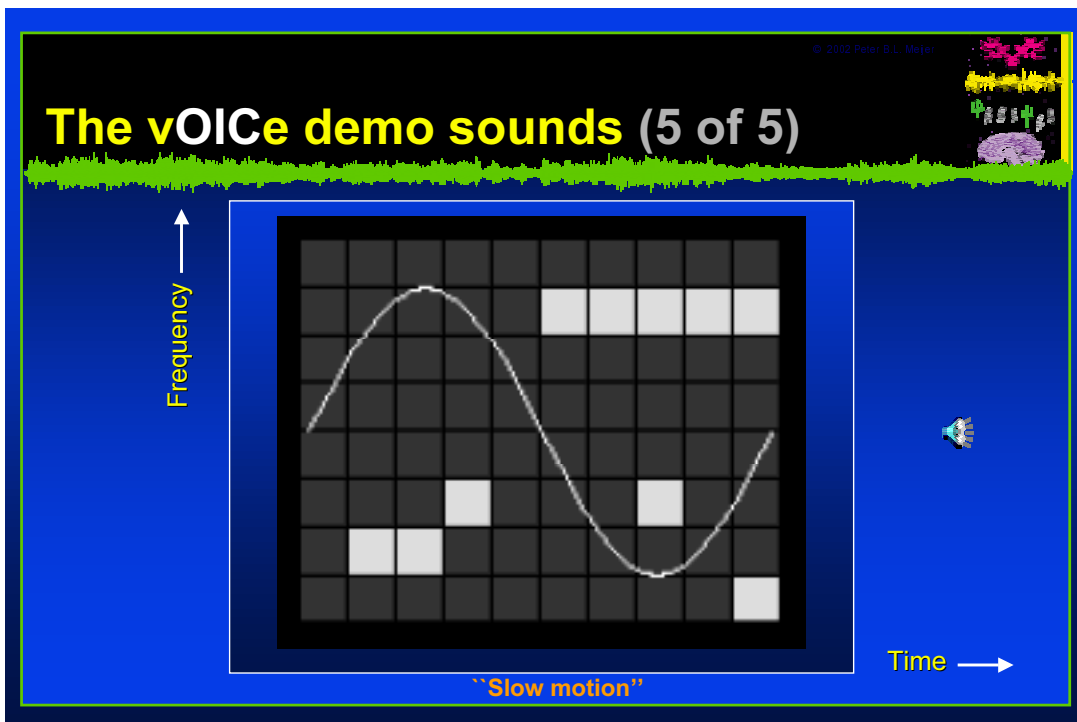
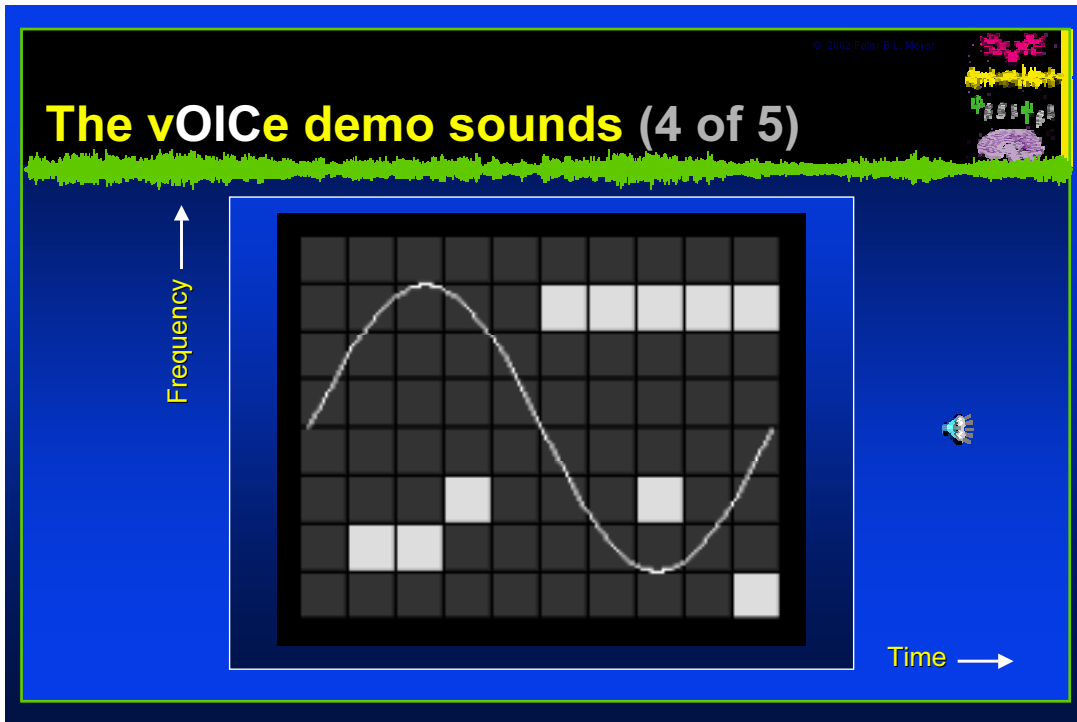


Frequency ↑

Time →








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## The vOICe for orientation (1 of 2)




Frequency ↑

Time →

This slide shows a wide-angle view of a paved plaza in front of a white building with a grid of windows. A mouse cursor is visible on the right side of the frame. The slide is titled "The vOICe for orientation (1 of 2)" and includes a copyright notice for Peter B.L. Meijer. The axes are labeled "Frequency" (vertical) and "Time" (horizontal).

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## The vOICe for orientation (2 of 2)



Frequency ↑

Time →

This slide shows a closer view of the white building's facade with a grid of windows. A mouse cursor is visible on the right side of the frame. The slide is titled "The vOICe for orientation (2 of 2)" and includes a copyright notice for Peter B.L. Meijer. The axes are labeled "Frequency" (vertical) and "Time" (horizontal).

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## The vOICe first-person perspectives

### *So, what do blind users say?*



Some accounts from a late-blinded woman in the USA who has been wearing The vOICe daily from mid 2000

*(No claims are made that this is representative!)*



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## The vOICE first-person perspectives

*User quote:*

**As a person who was blinded later in life I can say that the soundscapes seem to trigger a sense of vision for me.**

At first you might say I noticed only the soundscapes as they indicated changing patterns. I was not at this time actually seeing as I feel I do now. Rather just experiencing the soundscapes as I walked around.

**After a few months I was not concentrating on the changing sounds rather just accepting the input as background information and translating it into images.**

*Vision is (and should be) a largely subconscious process*

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## The vOICE first-person perspectives

*User quote:*

**What is significant to realize is The vOICE allows you to experience your surroundings in a 3-dimensional form.** When I am not wearing the program my contact with the world is limited to sound and touch. When wearing the program you can extend these senses to include the sight the program provides. **I look across my study while using the program and see the scanning table then the small book case in back of the table with an image of the door opening on the left of the scene.** Take off the program and this full, rich environment of seeing different structures is lost and I am returned to perceiving the world in a flattened 2-dimensional form. **Wearing the Seeing With Sound program is like stepping from total darkness into light.**

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## The vOICE questions...

**Psychology / Philosophy / Neuroscience :**

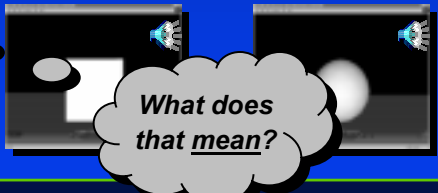
- How will first-person experiences evolve over time?
- Is there anything truly special at all about vision?
- What is the relation to the “Molyneux problem”?
- Neural plasticity as a function of (critical) age?
- Measurable effects of neuroplasticity? What effects?
- Occipital lobe (“visual” cortex) activated by sound:  
Is that vision or “just” extended auditory processing?

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## Philosophy and The vOICE

**17th Century “Molyneux problem” revisited?**

- **Q:** Would someone born blind, in case sight was restored, be able to **tell a cube from a sphere by sight alone?**  
**A:** “No” (according to John Locke & William Molyneux)
- **Q:** Would someone born blind, using “seeing-with-sound”, be able to **tell a cube from a sphere by “sight” alone?**  
**A:** “Yes”



What does that mean?

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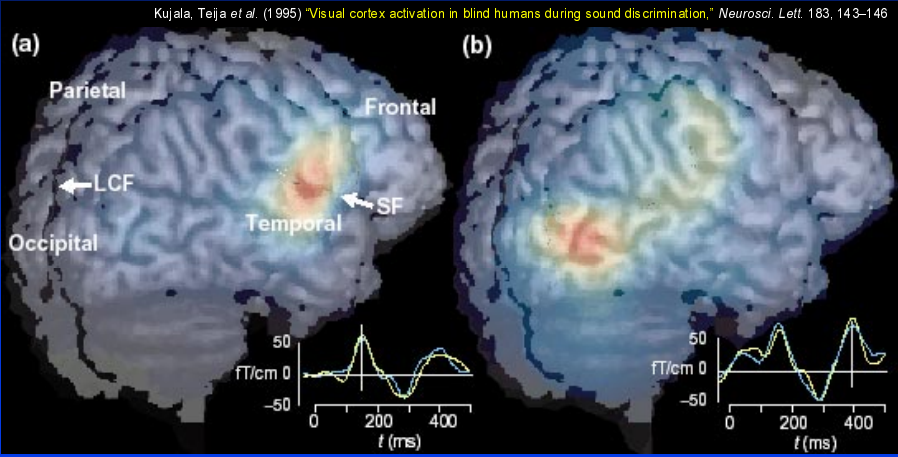
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# Neuroscience:

## Sound can activate “visual” cortex of blind

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Kujala, Teija et al. (1995) "Visual cortex activation in blind humans during sound discrimination," *Neurosci. Lett.* 183, 143–146



**(a)** Parietal, Frontal, LCF, Occipital, Temporal, SF

**(b)**

fT/cm 50 0 -50

t (ms) 0 200 400

fT/cm 50 0 -50

t (ms) 0 200 400

**Early-blind person detecting pitch changes**

## Neuroscience: Sound can activate "visual" cortex of blind

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Adapted from Weeks, Robert et al. (2000) "A positron emission tomographic study of auditory localization in the congenitally blind," J. Neurosci., 20, 2664-2672

*Early-blind person  
sound localisation*

sagittal 72  
0  
-104 VFC VAC 68  
coronal  
0  
64  
transverse  
0  
64  
Z value  
6  
4  
2  
1

## Neuroscience: Sound can activate "visual" cortex of blind

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Pascual-Leone, Alvaro (2002)  
"Masking the eyes to unmask the brain"  
Unpublished results

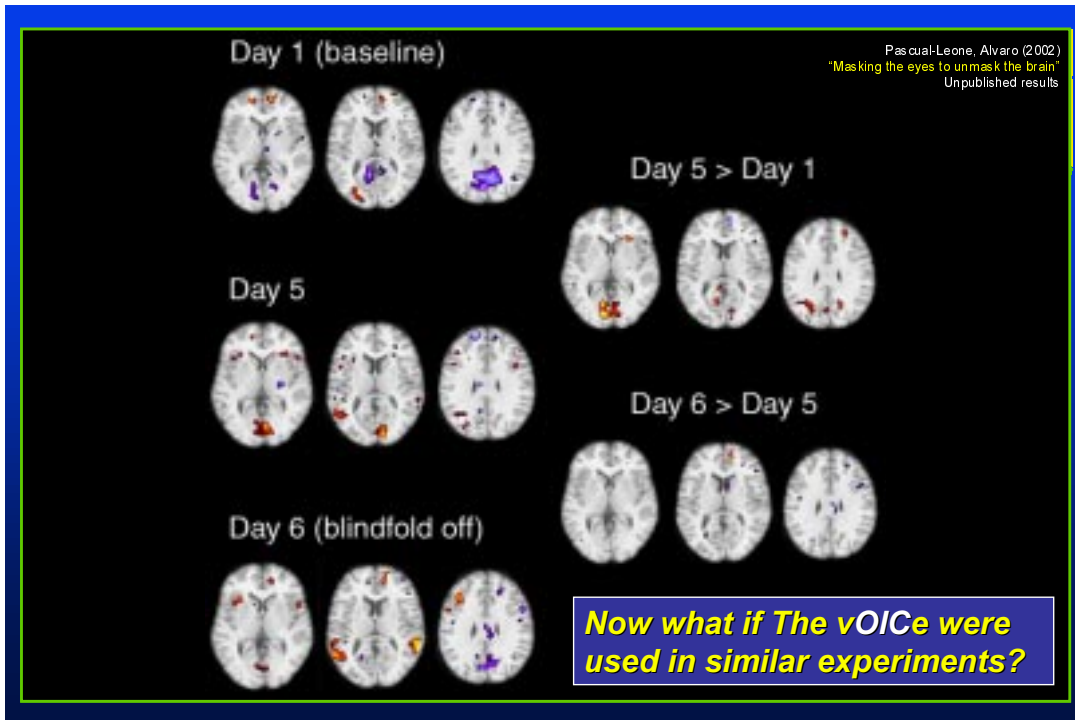
*Rapid plasticity  
via unmasking?*

*Blindfolded sighted  
detecting pitch changes*

*Measurable changes within one week*

Day 1 (baseline)  
Day 5  
Day 6 (blindfold off)  
Day 5 > Day 1  
Day 6 > Day 5





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## The vOICe questions...

**Psychology / Philosophy / Neuroscience :**

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Is that vision or "just" extended auditory processing?

*No third-person (scientific) answer, but a first-person reply →*

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## The vOICe first-person perspectives

*User quote, after hearing the NIC2001 presentation:*

One thing which struck me about Peter's presentation. **Was the question is the soundscape being related as sound input or visual input.** Since I am now so comfortable with the information provided by the program I did not stop to think of this question. **Sure the soundscapes are sound but it creates a different sort of input for my mind. The sound of music or a voice is just that sound. yet the soundscapes generate sight.** The sound information seems to enter my ears and is processed between my ear section of my head. The soundscape information is placed forward from my left temple across my eyes to my right temple. **They are two distinct separate areas of consciousness. this may seem strange. for sound to generate two different types of input. I can not explain it. I just am aware it is true.**

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## The vOICe: The Future

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Nature, Vol. 416, March 7, 2002, pp. 12-14

### Key directions

- Await user/market acceptance and user achievements
- Await evidence pro/con from Neuroscience research
- Develop further refinements in sound rendering



## The vOICe: Conclusions

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### Seeing with Sound

- ✓ Needs more research
- ✓ Is affordable technology
- ✓ Is non-invasive
- ✓ Is available **Now!**

**Free**  
evaluation software at  
<http://www.seeingwithsound.com>