



Seeing with Sound – The vOICe



Photography: courtesy Barbara Schweizer

blind user of The vOICe in the US

Overview

- sensory substitution
 - *image-to-sound*
 - *visual perception*
- neuroscience
 - *brain plasticity*
- conclusions

2

4%

3

sensory substitution with auditory display



blind user
hears
rising tone



rising
line!

8%

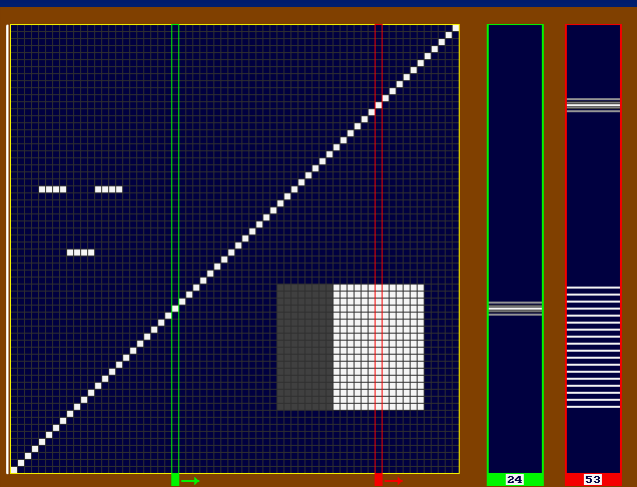
4

The vOICe image-to-sound mapping



Frequency
y

spectrographic
synthesis

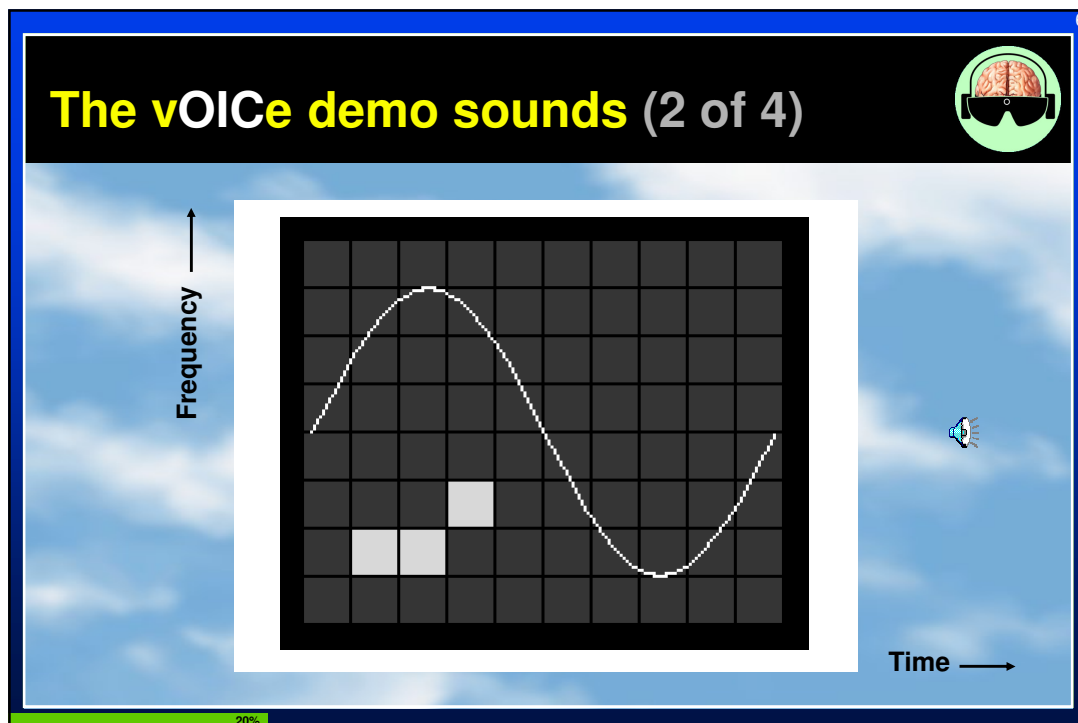
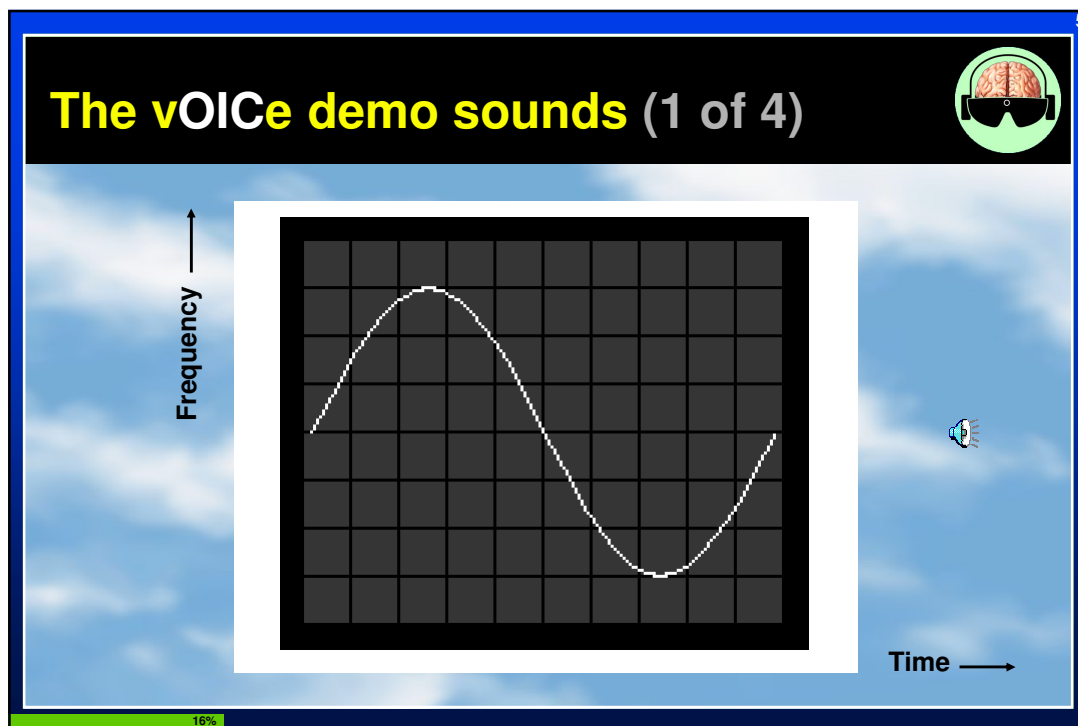


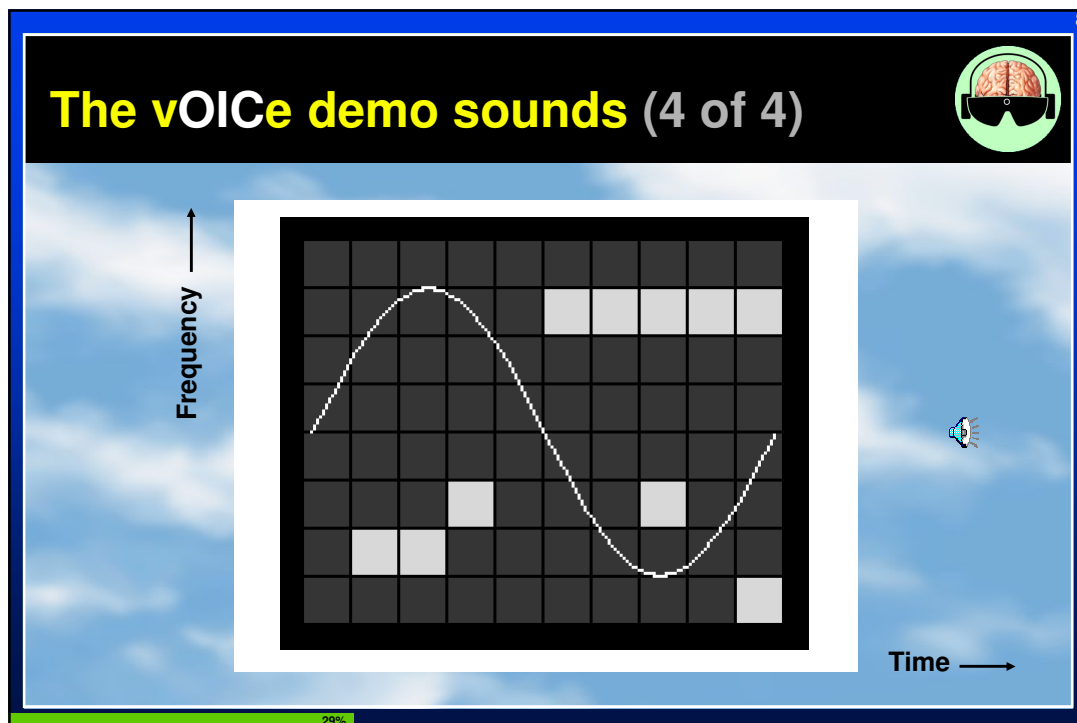
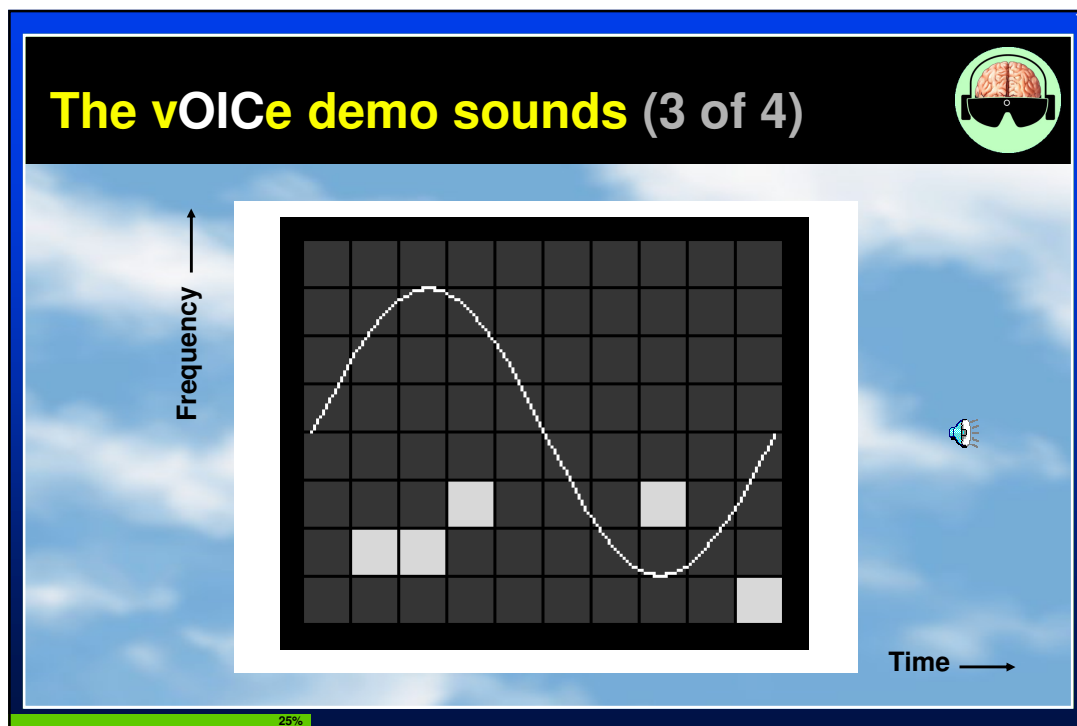
Time →

24 53

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12%





9

Grasping exercise (can be mastered in a few hours)

33%

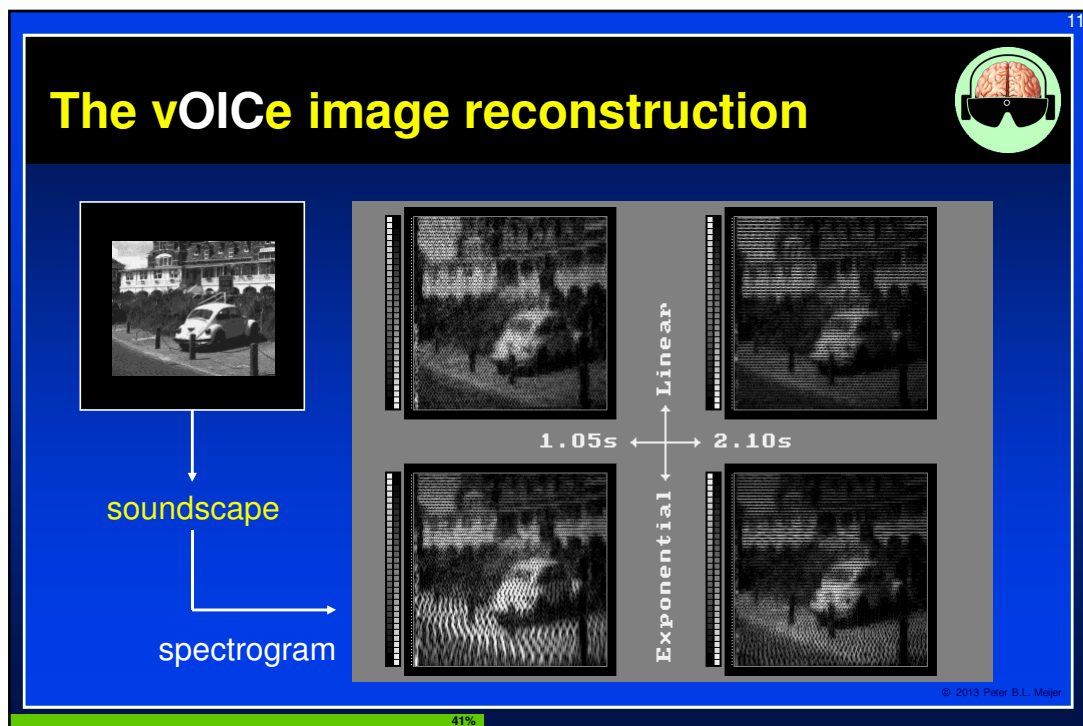
The vOICe image perception

10

how far does it go for **complex images**?

first perform a **technical validation** of
image information preservation →

37%



12

The vOICe image perception

The diagram illustrates the process of image perception using sound. It shows a blue sky with white clouds. A black box contains text about technical and perceptual resolution. A small icon of a brain with glasses is in the top right corner.

***technical* resolution** between **30 x 30** and **60 x 60** proven by reconstruction

what about ***perceptual* resolution?**

45%

13

perceptual resolution (visual acuity)

PLoS ONE 7(3), 2010, ``Visual' Acuity of the Congenitally Blind Using Visual-to-Auditory Sensory Substitution'', by Ella Striem-Amit, Miriam Guendelman and Amir Amedi:

“Group performance differed statistically from chance level at all visual acuities up to **20/320**”

“The visual acuity of the individual participants varied between **20/200** and **20/600**”

“Interestingly, 5 of the 9 participants (55%) had visual acuity that exceeded the visual acuity threshold for blindness as defined by the WHO” (**20/400**)

50%

14

The vOICe esthetic qualities?

The vOICe: visual content comes first,
esthetic qualities second

no compromises!

54%

15



The vOICe esthetic qualities?

sighted users dislike soundscapes
blind users have no problem with it

representative quotes (2 blind users)
"I have never found the soundscapes unpleasant"
"The rules of music should not apply. It has never bothered me even after extended use"

58%

16



The vOICe → artificial synesthesia?

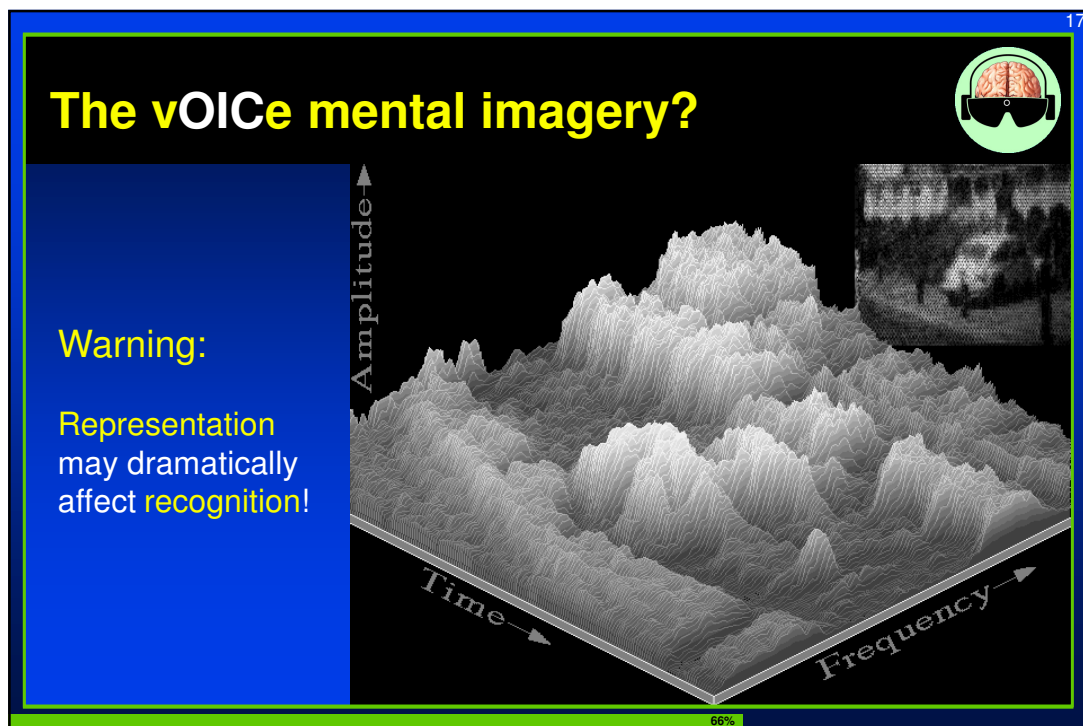
PF, late blind female, US, after hearing about visual cortex implants:

Just sound?.... No, It is by far more, it is sight ! There IS true light preception generated by the vOICe. When I am not wearing the voice the light I perceive from a small slit in my left eye is a grey fog. **When wearing the vOICe the image is light with all the little greys and blacks. Yet a definite light image.** True it is not color but it is definitely like looking at a black and white TV show. **The light generated is very white and clear then it erodes down the scale of color to the dark black. I don't really see adifference in this light as compaired to the "light phosphenes " they are talking about.**

See also: Ward, J. and Meijer, P., "Visual experiences in the blind induced by an auditory sensory substitution device", *Consciousness and Cognition*, Vol. 19, 2010, pp. 492–500.

62%

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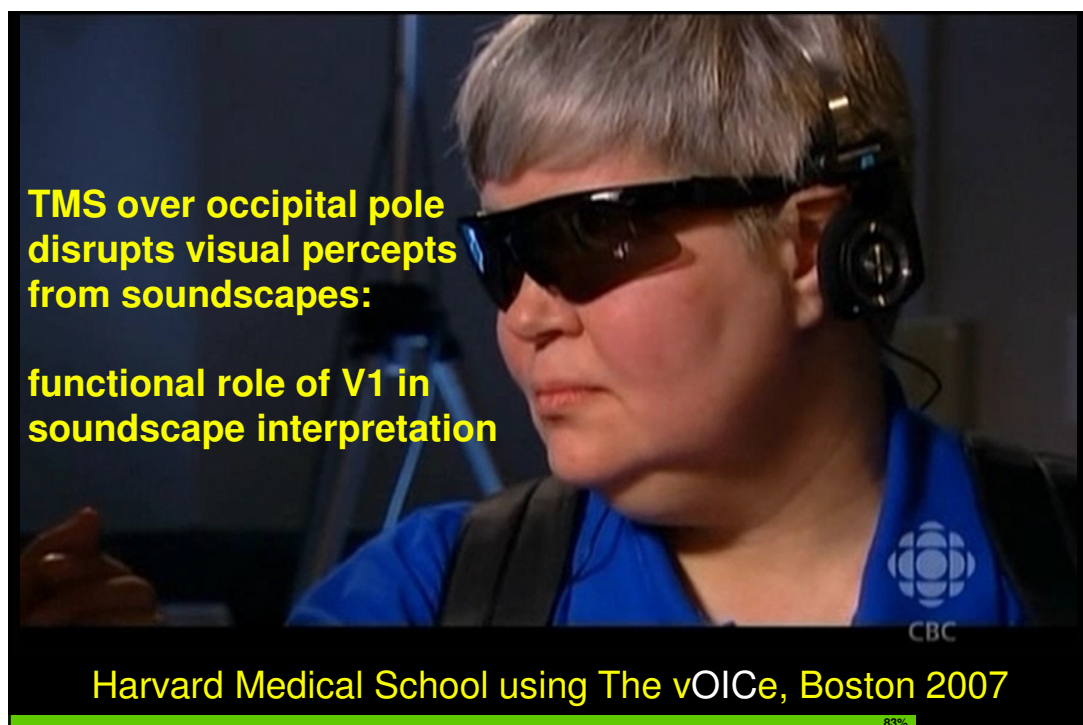
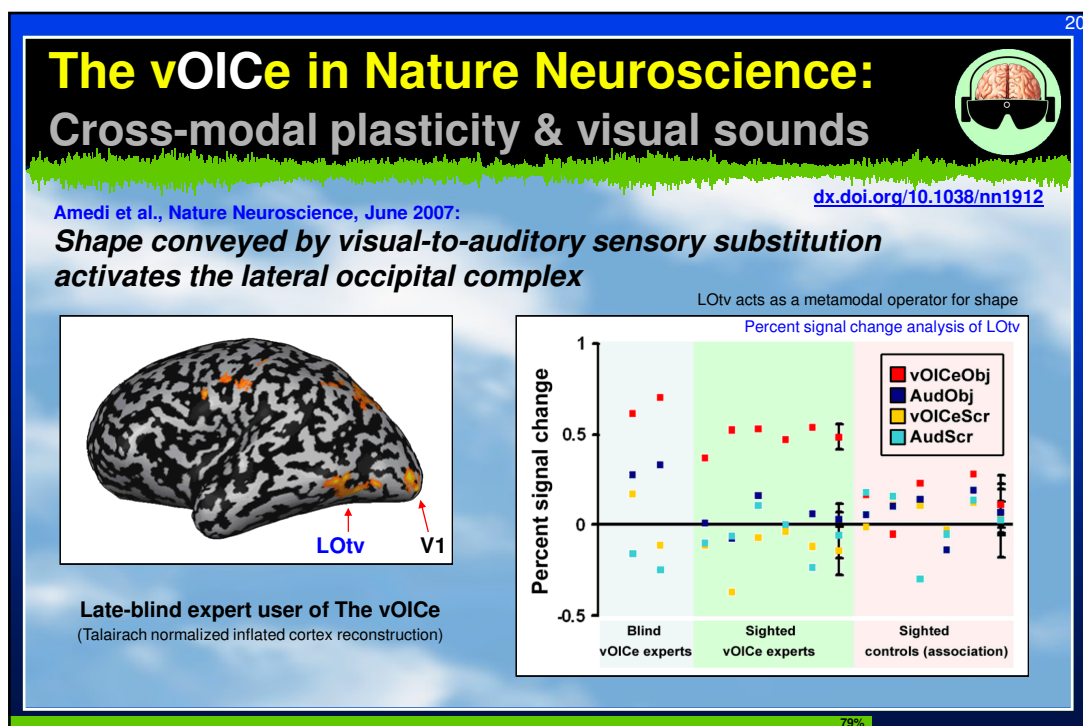
19

neuroscience research

- ✓ **sound** activates **visual cortex of blind**
- ✓ **The vOICe** sounds also activate **LOtv** **shape recognition area of blind users** (natural sounds do not activate LOtv)

Harvard Medical School, 2007

75%



22

The vOICe in Current Biology:

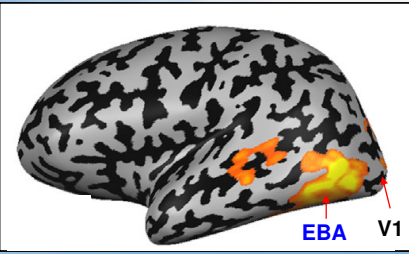
Cross-modal plasticity & visual sounds



dx.doi.org/10.1016/j.cub.2014.02.010

Ella Striem-Amit & Amir Amedi, *Current Biology*, March 2014:
Visual cortex extrastriate body-selective area activation in congenitally blind people 'seeing' by using sounds

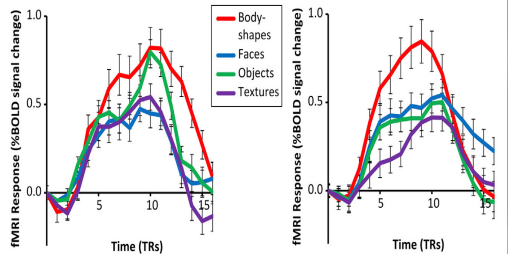
EBA acts as a metamodal operator for body shapes?



Functional connectivity of EBA in the congenitally blind (n = 13)
(Talairach normalized inflated cortex reconstruction)

Selectivity for body-shapes - Activation time-course

Blind (via SSD, n=7, RFX) Sighted (Visually, n=7, RFX)



87%

23

setups for The vOICe cost < \$1000, or < \$500 when using a netbook PC





Michael Proulx

91%

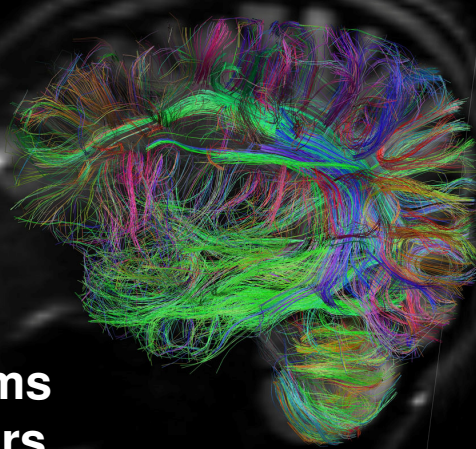
**attainable functional
vision for use in daily
living?**

**not easy: like learning
a foreign language**

- ✓ need training programs
- ✓ need research partners

training & motivation...

<http://www.nibib.nih.gov/Research/Highlights/Connectome>



95%

25

conclusions



Pranav Lal, a blind user of The vOICe in New Delhi

- ✓ R&D ongoing
- ✓ affordable
- ✓ non-invasive
- ✓ available worldwide
- ✓ must *learn* to see!

thank you!

100%

