



ISTITUTO ITALIANO
DI TECNOLOGIA
UNIT FOR VISUALLY IMPAIRED PEOPLE

Monica Gori

Researcher Tenure Track - Principal Investigator
Tenure Track Researcher

Research Line

Unit for Visually Impaired People

Center

IIT Center for Human Technologies / Erzelli

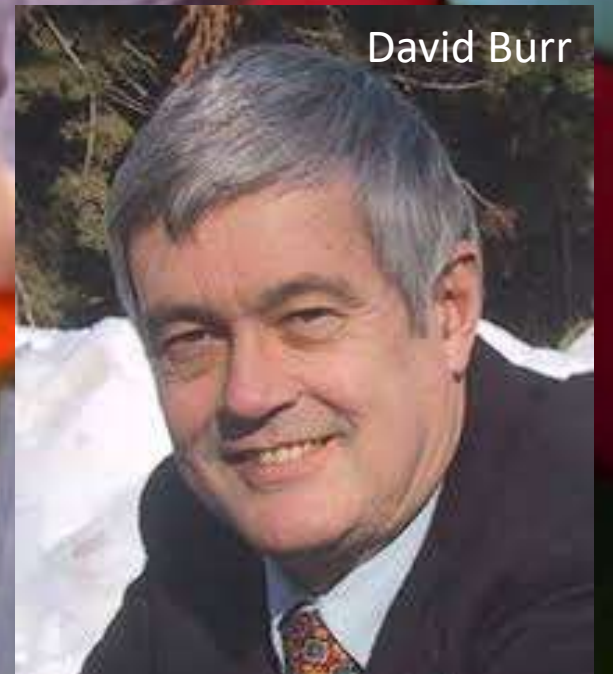


Tante modalità sensoriali ma un solo percetto: tecnologia per la riabilitazione e l'apprendimento

Monica Gori



Psicologia



David Burr

Tecnologia



Giulio Sandini





Psychologist

Engineer

Engineer

Engineer

Psychologist

Engineer

Psychologist

Psychologist

Psychologist

Engineer

Physicist

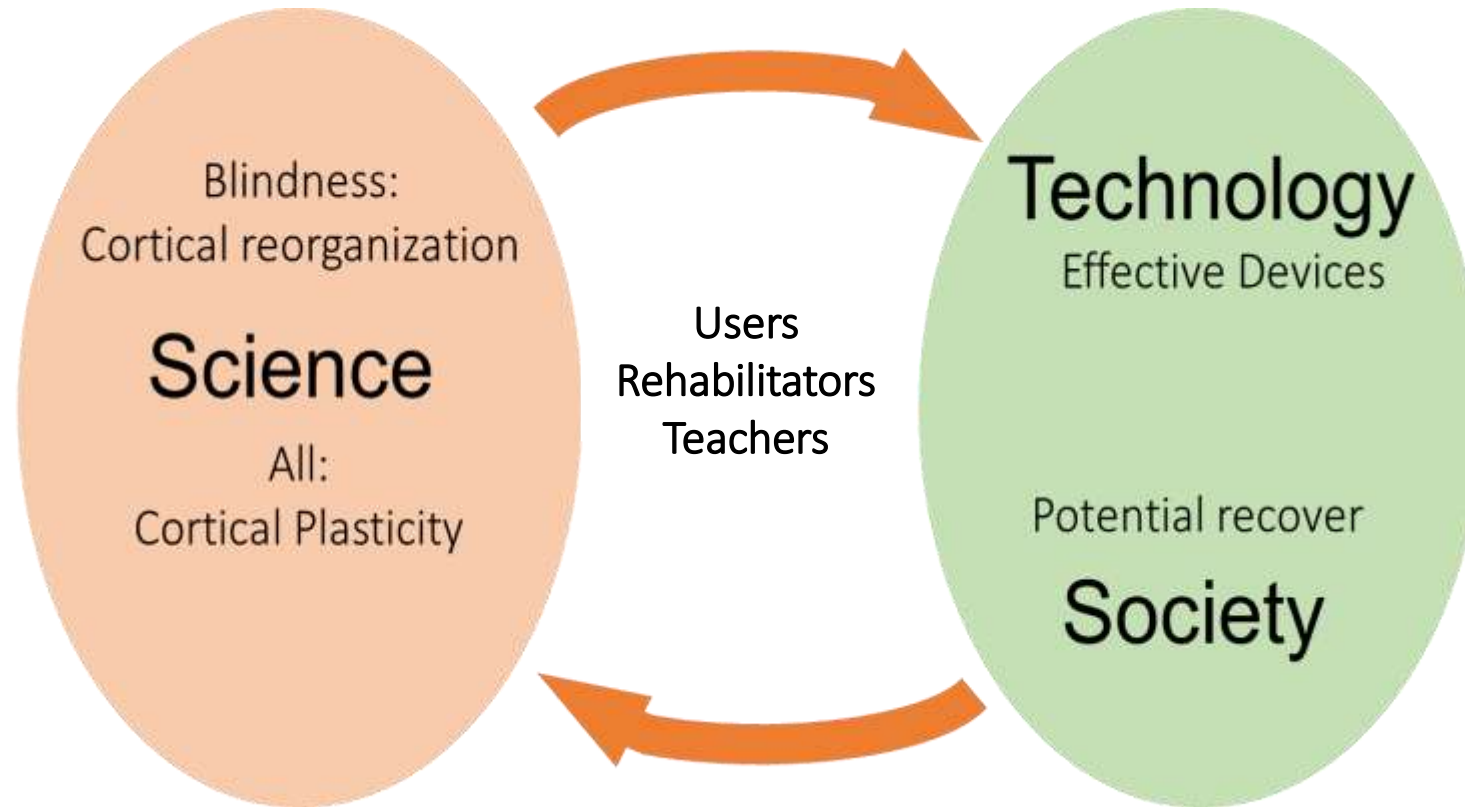
Psychologist

Psychologist

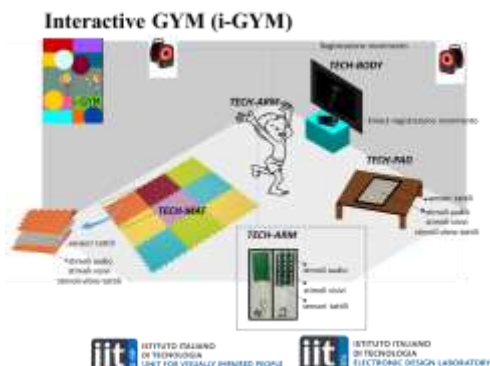
Engineer



The unique U-VIP approach



Network and Joint labs: 2000 VI children 0-18 per year



IRCCS Ist. Neurologico C.
Mondino, Pavia
906 children age 0-18

ASSOCIAZIONE
la Nostra Famiglia

IRCCS E. Medea, Bosisio Parini, LC
303 children age 0-18



CHIOSSONE
onlus
PER CIECHI E IPOVEDENTI DAL 1868
Istituto David Chiossone
218 children age 0-18

irifor RICERCA, FORMAZIONE
RIABILITAZIONE
per la disabilità visiva



IRCCS FONDAZIONE
STELLA MARIS

I.Ri.Fo.R-Pisa
349 children age 0-18



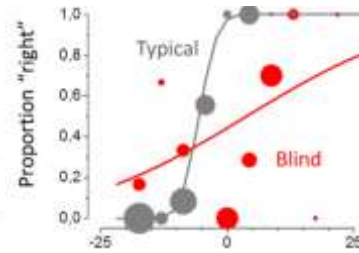
irifor RICERCA, FORMAZIONE
RIABILITAZIONE
per la disabilità visiva
I.Ri.Fo.R-Firenze
159 children age 0-18

+ schools in Genoa 1000 children per year

Methodology



Psychophysical quantification



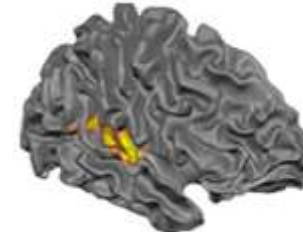
$$\sigma_{VH}^2 = \frac{\sigma_V^2 \sigma_H^2}{\sigma_V^2 + \sigma_H^2} \leq \min(\sigma_V^2, \sigma_H^2)$$

Quantification of multisensory integration with Bayesian Modeling

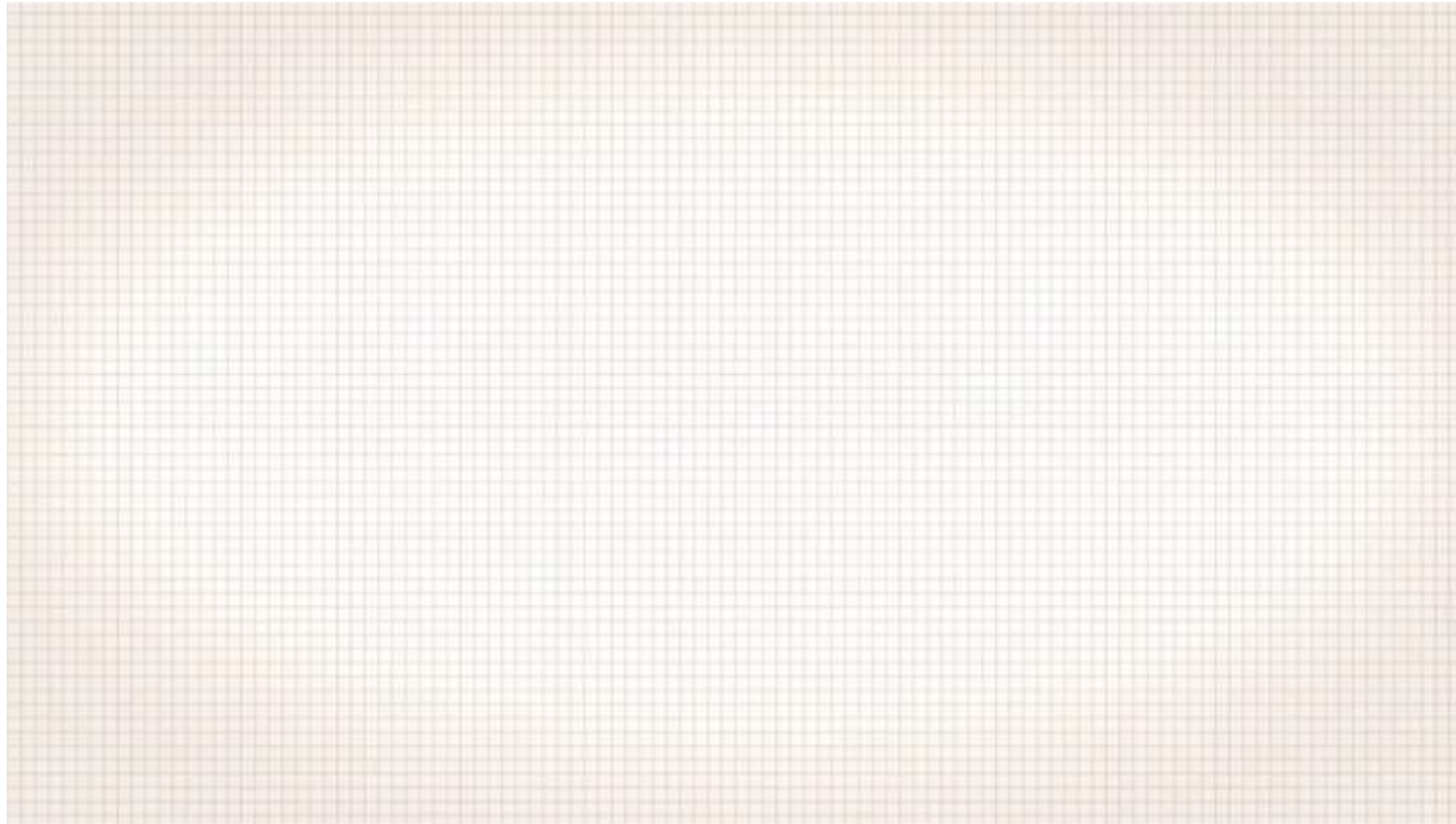


EEG, fMRI
Audio, tactile processing

Motor responses, orienting responses,
Reaction times



La visione è affidabile?

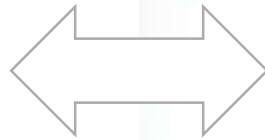


Lo potete scaricare dal sito www.wedraw.eu con molti altri video



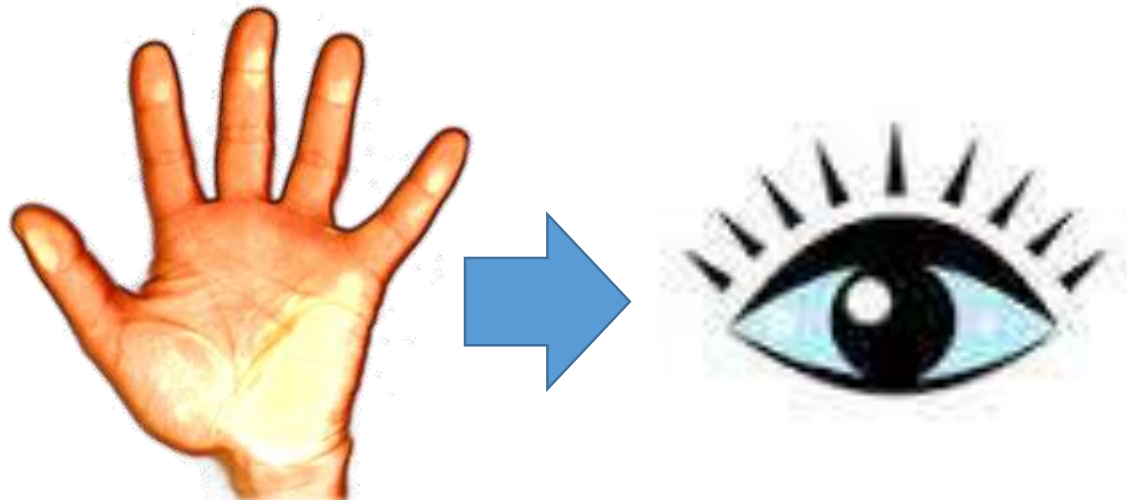
Come interagiscono le modalità nel bambino?







Il tatto insegna alla vista il
concetto di dimensione di oggetti



Bishop George Berkeley:

*An Essay Towards a
New Theory of Vision*
(1709)

Preposition 45

Il tatto educa la vista

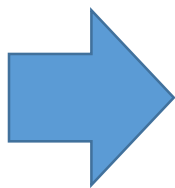
Il tatto calibra la vista



Compito di orientamento



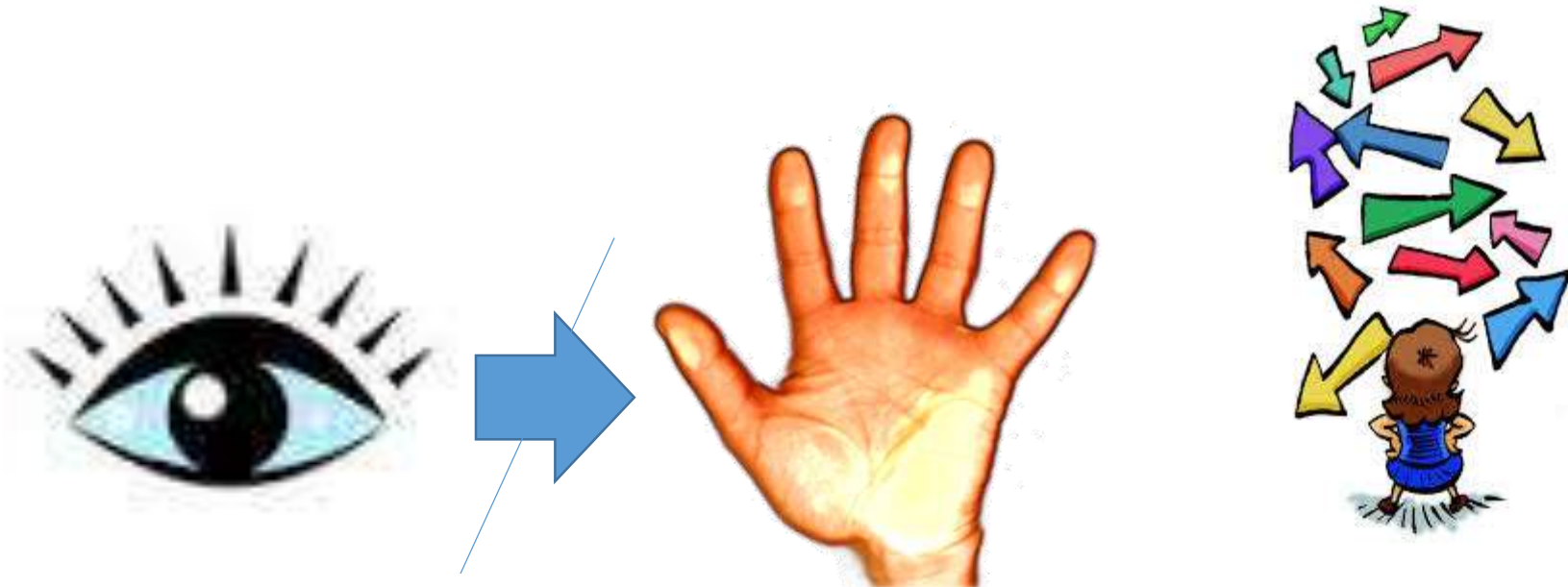
La vista insegna al tatto il
concetto di orientamento di
oggetti



Disabilità: ma cosa succede se
una modalità che serve ad
insegnare manca come in bambini
con disabilità?



Bambini con disabilità visiva:
problemi a riconoscere tattilmente
l'orientamento di oggetti



Dimensione

4 5 6

Visione



Tatto

Visione

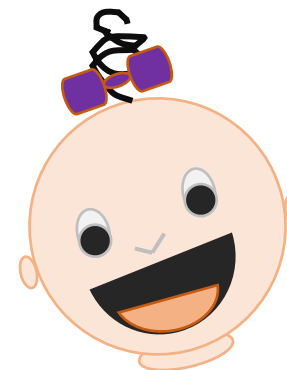


Tatto

Visione



Tatto



Orientamento



Tatto



Visione

Tatto

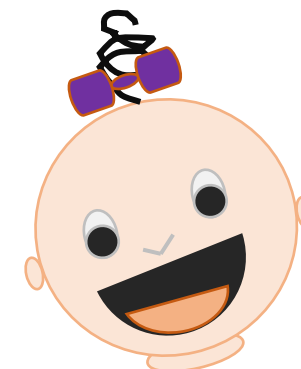


Vsione

Tatto



Visione



Tatto



Visione

Tatto

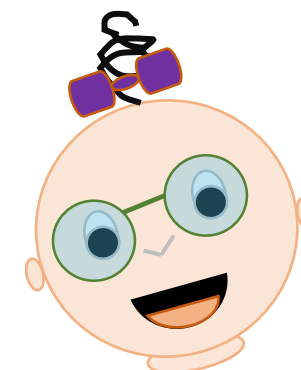


Visione

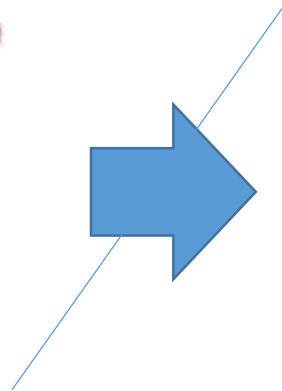
Tatto



Visione



Bambini con disabilità motoria:
problemi a riconoscere visivamente la
dimensione di oggetti



Orientamento



Tatto



Vista

Tatto



Vista

Tatto



Vista



Dimensione



Vista



Tatto

Vista



Tatto

Vista



Tatto



Vista



Tatto

Vista

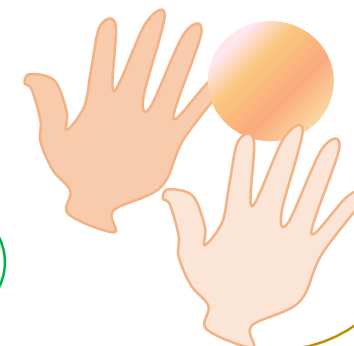


Tatto

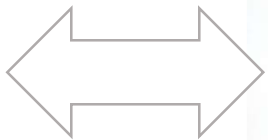
Vista



Tatto





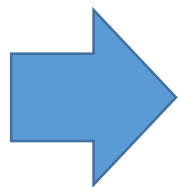
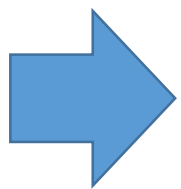


SPACE

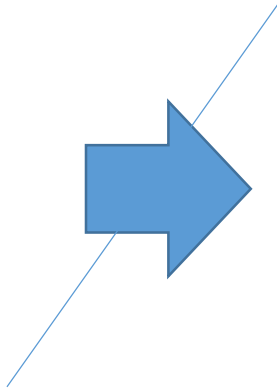


TIME





Bambini con disabilità visiva:
problemi a riconoscere acusticamente
la posizione di suoni

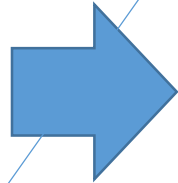




Enhanced auditory skills in blind individuals?
Not always true, in children even more problematic



Bambini con disabilità acustica:
problemi a riconoscere visivamente il
ritmo di luci





Visione



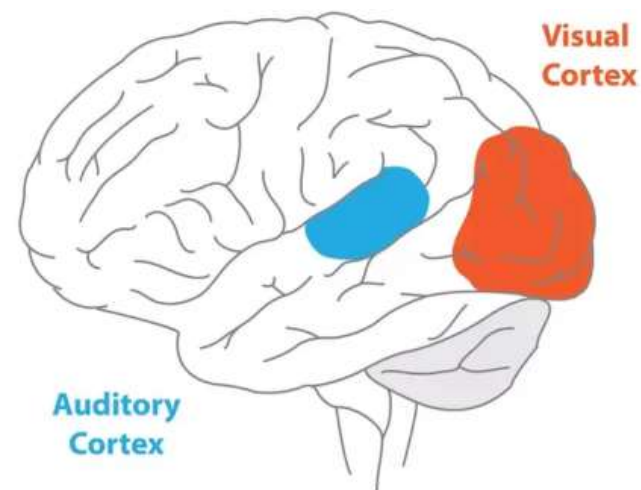
Spazio



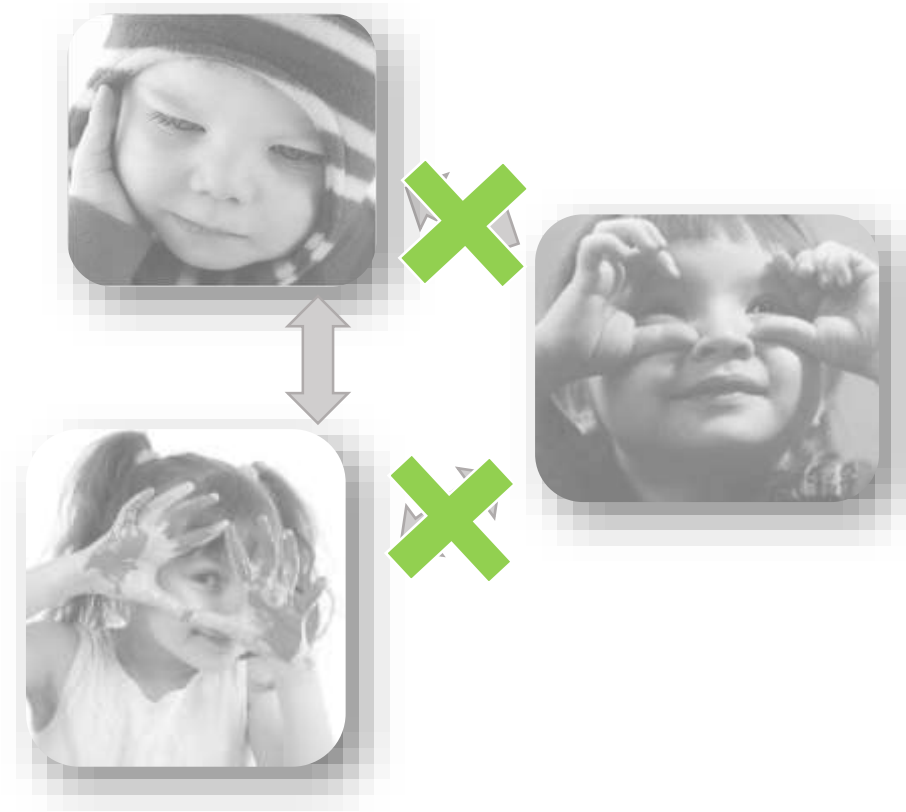
Udito



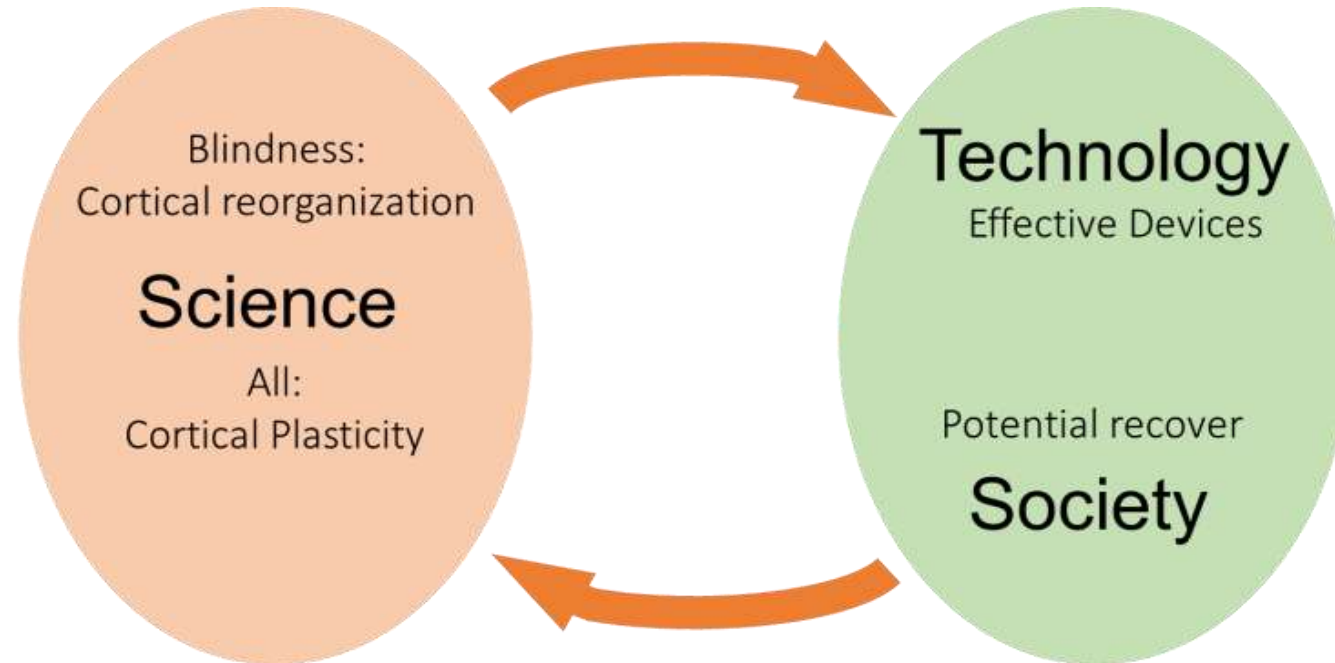
Tempo



Interazione tra modalità sensoriali nel bambino

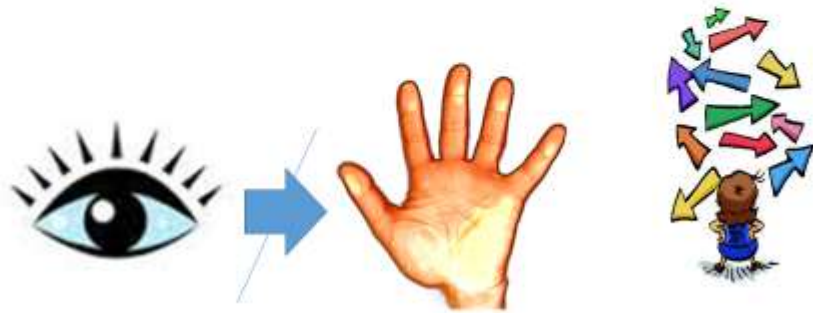


Riabilitazione



ISTITUTO ITALIANO
DI TECNOLOGIA
UNIT FOR VISUALLY IMPAIRED PEOPLE

Bambini con disabilità visiva:
problemi a riconoscere tattilmente
l'orientamento di oggetti



Gori et al. Current Biology 2010

Bambini con disabilità visiva:
problemi a riconoscere acusticamente
la posizione di suoni



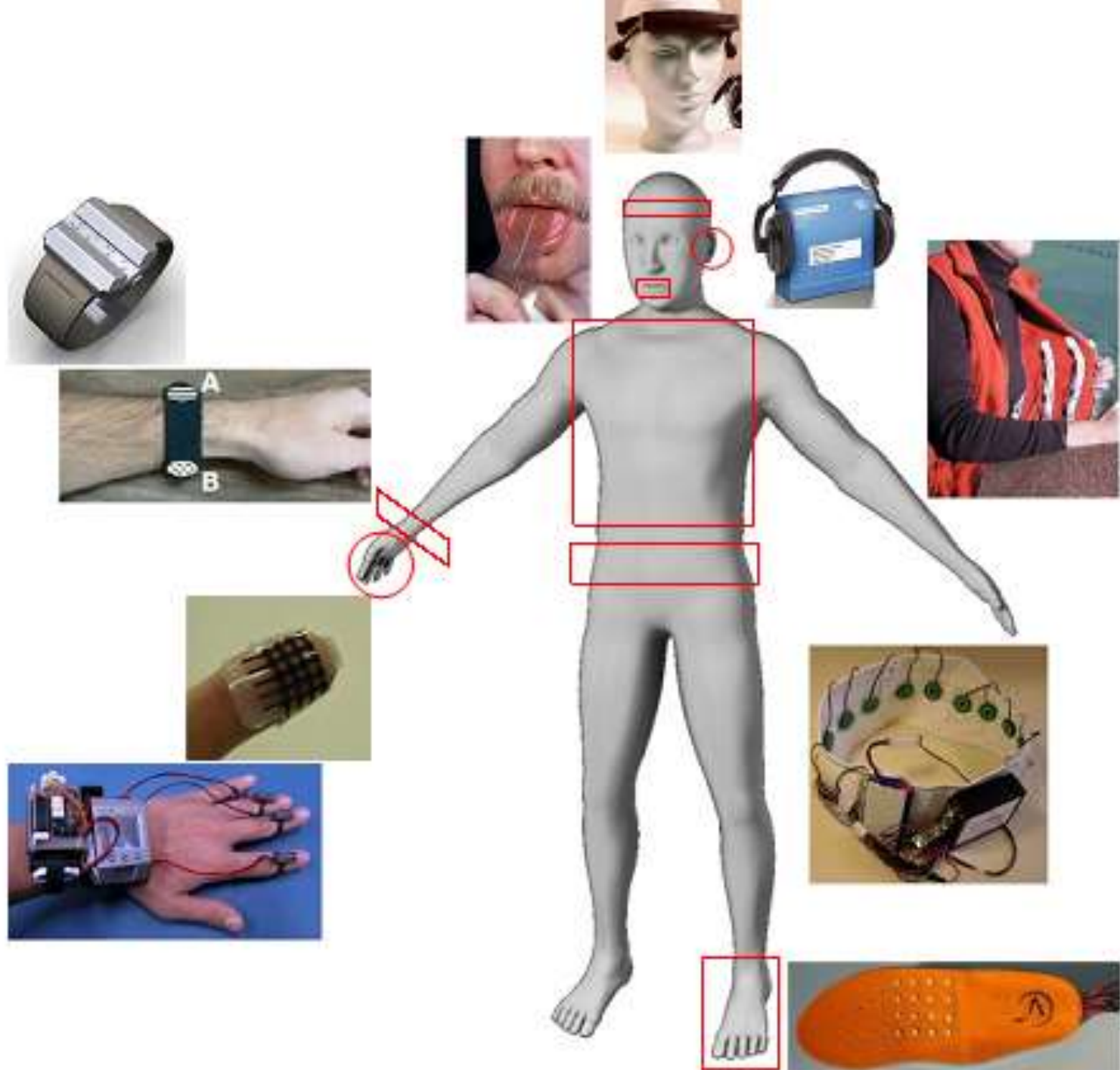
E molte altre

Come risolvere questi problemi?



A photograph of two young boys sitting on a green carpeted floor. The boy on the left, wearing a blue button-down shirt, is holding a small, dark, rectangular electronic device with both hands. The boy on the right, wearing a brown patterned sweater, is looking down at the device with a focused expression. In the background, there are colorful toys and a map of the world on the wall. Overlaid on the right side of the image is white text.

**300 milioni
di persone con
disabilità
visiva
1.4 milioni
bambini ciechi**





SPRECHEN SIE
DEUTSCH ?





1 Inch-long camera hidden in sunglasses sends image to a handheld control unit



2 The control unit converts the image into a low resolution black, white and grey picture



3 Image recreated on a grid of 400 electrodes. Each one pulses according to how much light is in that area of the picture



5 Brain eventually learns to 'see' the shape detected on tongue



4 User 'feels' the shape and detects movement on their tongue

Troppa
attenzione





Bassa accettazione

Invasive system

Cognitive load

Training

Poor performance

Not clinically validated

Lack of multisensory integration

~~***Technology for children***~~



Devices for visually impaired people: High technological devices with low user acceptance and no adaptability for children

Monica Gori^{a,*}, Giulia Cappagli^a, Alessia Tonelli^a, Gabriel Baud-Bovy^b, Sara Finocchietti^a^a D-VIP: Unit for Visually Impaired People, Istituto Italiano di Tecnologia, Genova, Italy^b Robotics, Brain and Cognitive Science Department, Istituto Italiano di Tecnologia, Genova, Italy

Language Display Unit (LDB)

Sighted and blind adults



Review article

From science to technology: Orientation and mobility in blind children and adults

Luigi F. Cuturi^a, Elena Aggius-Vella^a, Claudio Campus^a, Alberto Parmiggiani^b, Monica Gori^{a,*}

Prosthesis for Substitution of Vision by Audition (PSVA)

K-sonar

SmartSight

Vibe

MusicEye

KNFB Reader

Prizmo 3

Voice Over and Talking Tap Twice (TTT)

Sighted and blind adults.

Blind adults

Blind adults.

Blind adults.

Blind adults.

Blind people.

Sighted and blind people.

Blind adults and children.

Of 48 devices:

20 SSD

14 Smart canes

14 Robotics guides

26 tested in sighted and blind

Only 2 for children

No, not commercialized

No, not commercialized

No, not commercialized

No, not commercialized.

Commercialized as K-sonar

No, not commercialized.

Yes, commercialized.

No, not commercialized.

Yes, commercialized.

Yes it was commercialized in the '70s.

Yes, via a smartphone app.

No, not commercialized

Yes, commercialized.

No, not commercialized.

No, not commercialized.

Yes, via a smartphone app.

Yes, it is an app for Android and iOS.

Yes, it is an app for Android and iOS.

Yes, they are built into smartphone's services.

Adaptability in children: if tested and used, distinction between preschool (<5 years old) and school children

Needs extensive training to be used. Never tested on children.

Needs extensive training to be used.

Never tested on children.

Never tested on children.

Never tested on children.

Never tested on children.

Never tested on children.

Never tested on children.

Tested on deaf children.

Never tested on children.

Never tested on children.

It has been used by adults and high school children. Not tested on preschool children.

Not tested on children.

Not tested on children.

It could be used in children but never tested yet

Not tested on children.

Not tested on children.

Not tested on children.

There is no record about it. The app can be downloaded by everyone.

There is no record about it. The app can be downloaded by everyone.

Tested and used by school children.



lo non posso usarlo



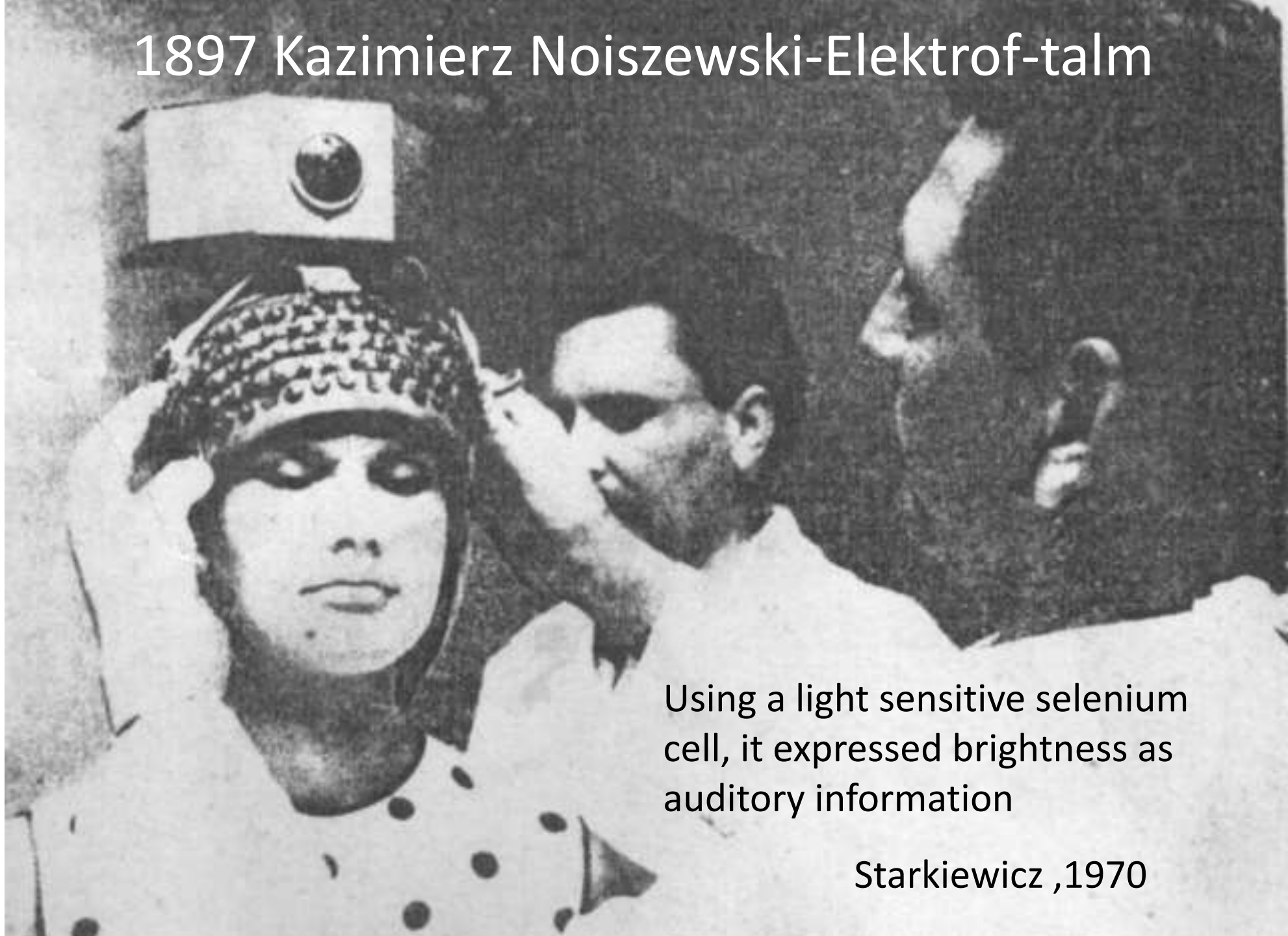


È importante
agire nei primi 3
anni di vita



Sistemi di riabilitazione per adulti

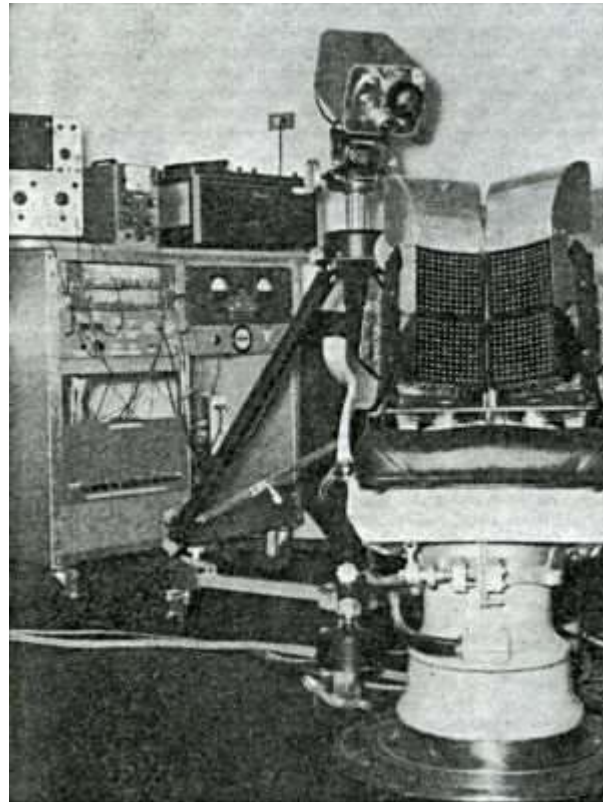
1897 Kazimierz Noiszewski-Elektrof-talm



Using a light sensitive selenium cell, it expressed brightness as auditory information

Starkiewicz ,1970

1960s Bach-y-Rita created the Tactile Visual Sensory Substitution (TVSS)



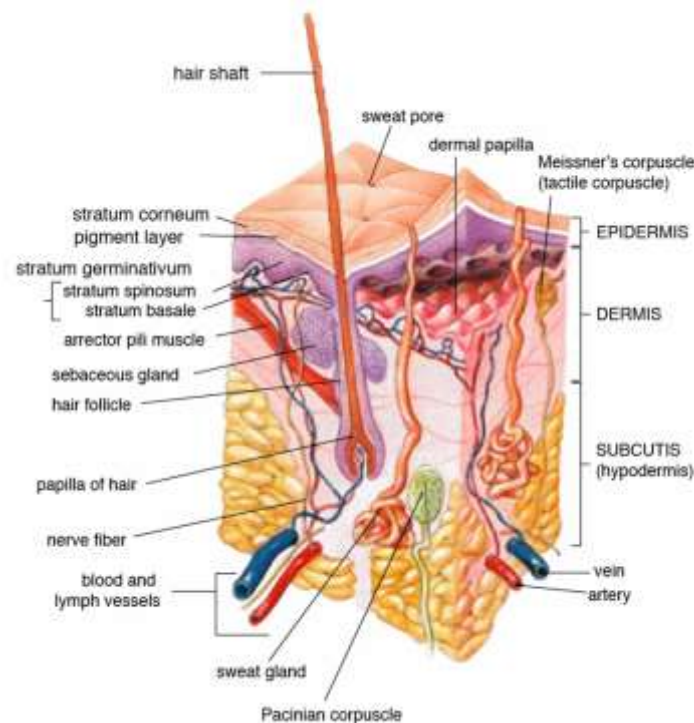
Four hundred solenoid stimulators are arranged in a twenty x twenty array built into a dental chair. The subject manipulates a television camera mounted on a tripod, which scans objects placed on a table in front of him.

P.Bach-Y-Rita, "Vision Substitution by Tactile Image Projection", Nature vol. 221, 1969, pp. 963-964



Sensory tactile system

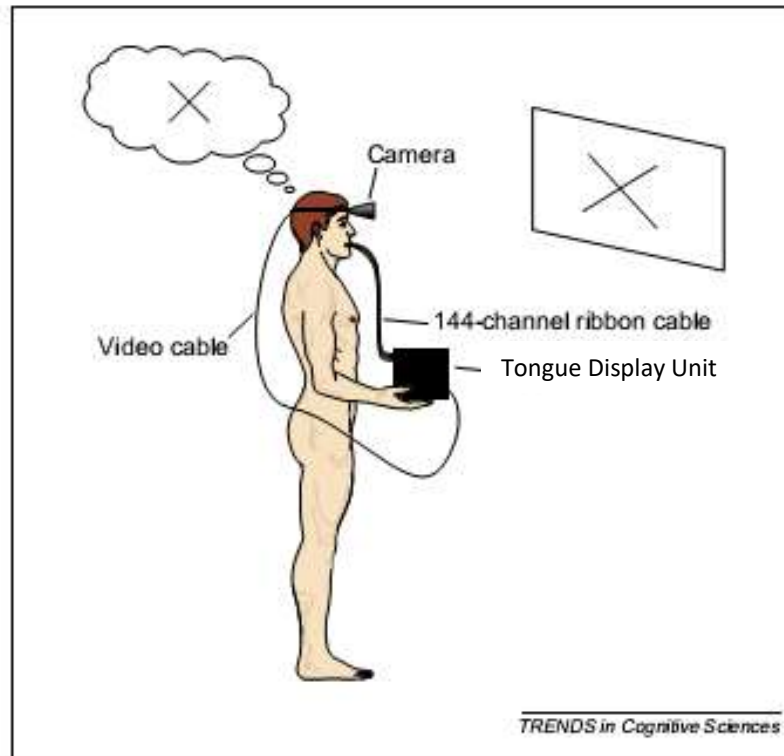
- 5 basic types of tactile receptors: Pacinian corpuscle, Meissner's corpuscle, Ruffini endings, Merkel nerve endings, and free nerve endings;
- types of stimulators: electrotactile or vibrotactile



Tactile Vision Sensory Substitution (TVSS)

- Paul Bach-y-Rita's
- Seeing through the skin receptors
- Visual information reaches the perceptual levels for analysis and interpretation via somatosensory pathways and structures
- Preferred area: tongue
- No two-point resolution issue!

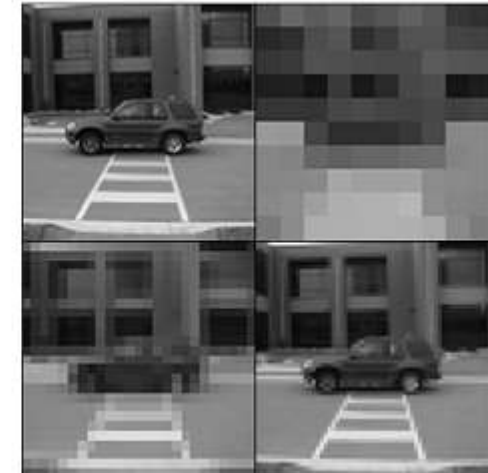
The BrainPort vision device (University of Montreal)



Translation occurs through brightness, intensity of stimulation



400 to 600 electrodes



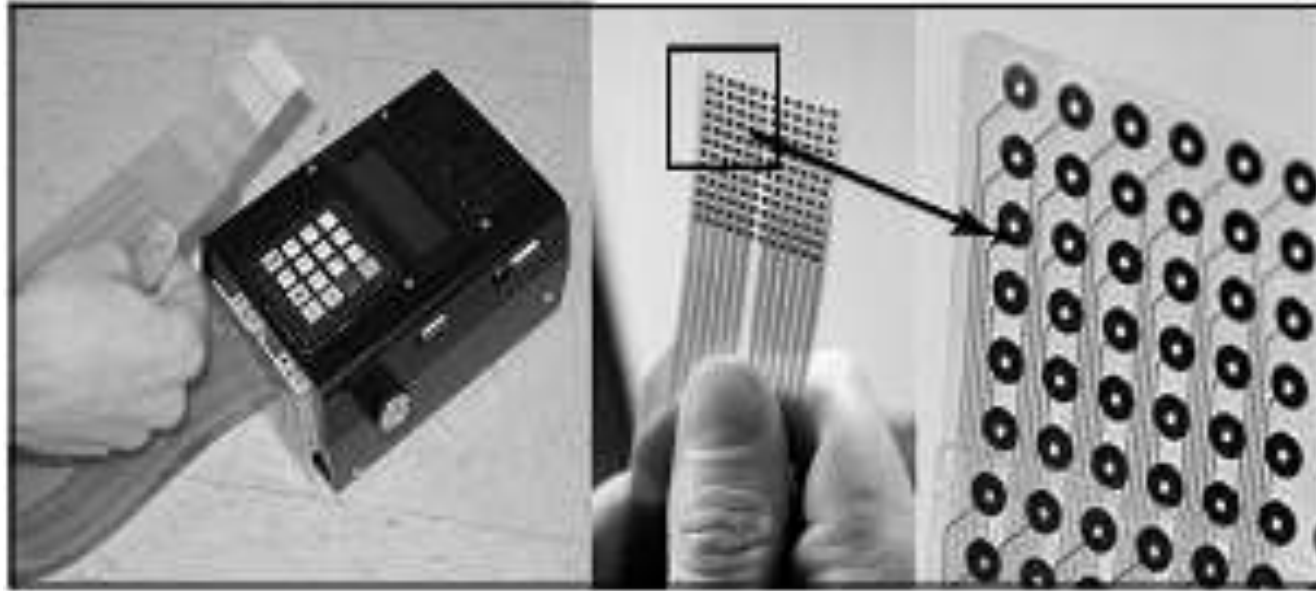
Pattern of 144 low-voltage pulse trains each corresponding to a pixel



Electrotactile stimuli are delivered to the dorsum of the tongue via flexible electrode arrays placed in the mouth, with connection to the tongue display unit (TDU) via a ribbon cable passing out of the mouth. An image is captured by a head-mounted CCD camera.

Pattern of 144 low-voltage pulse trains each corresponding to a pixel.

Tongue Display Unit (TDU) systems



University of Wisconsin (1998)

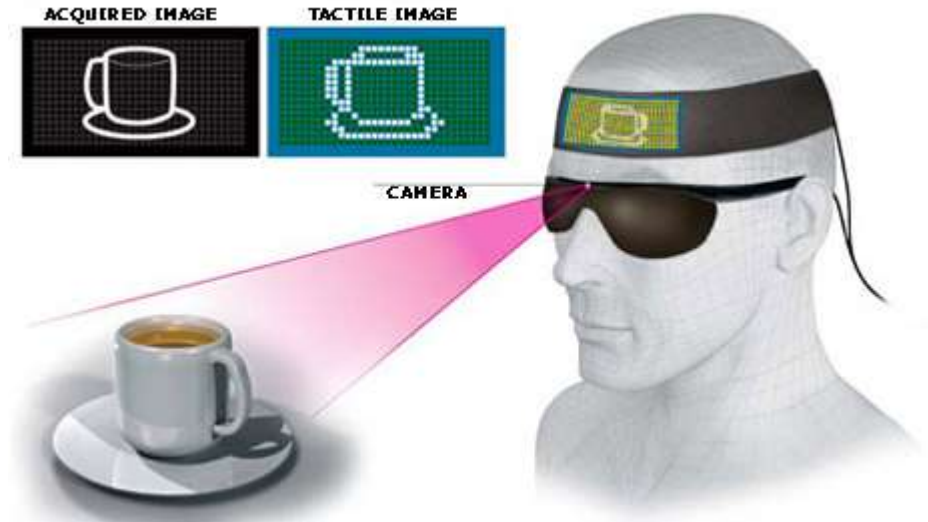


University of Montreal



Joseph Fourier University

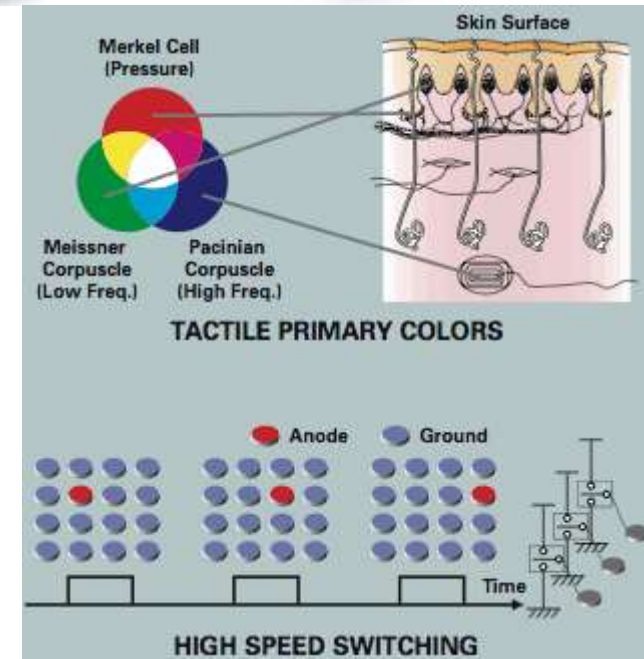
Forehead Retina System



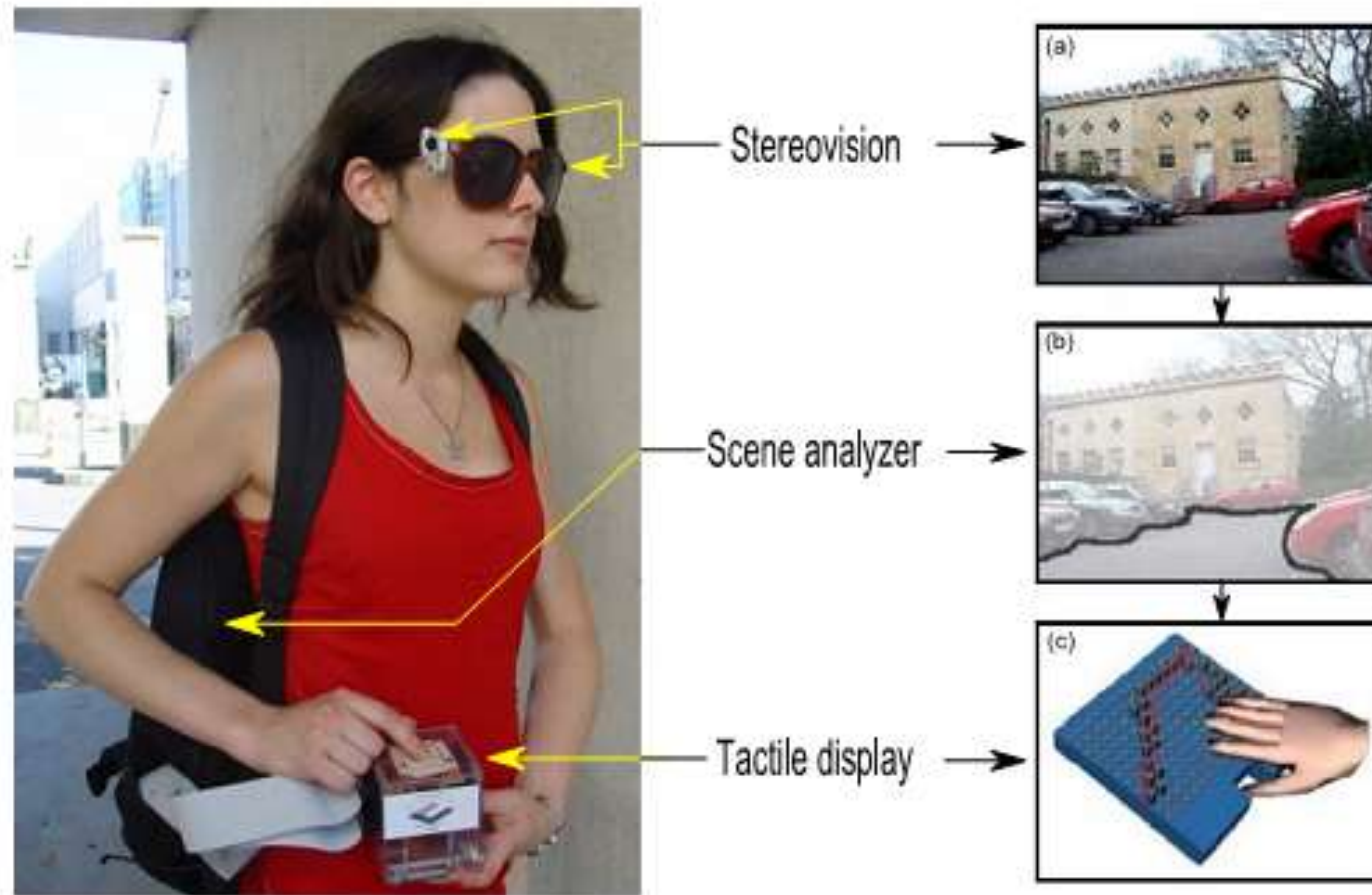
Yonezo Kanno, and Dr. Susumu Tachi.

It uses a grid of electrodes on the forehead and it is supposed to work in colour

A small camera and 512 forehead-mounted electrodes capture the frontal view, extract outlines, and convert the data to tactile electrical stimulation.

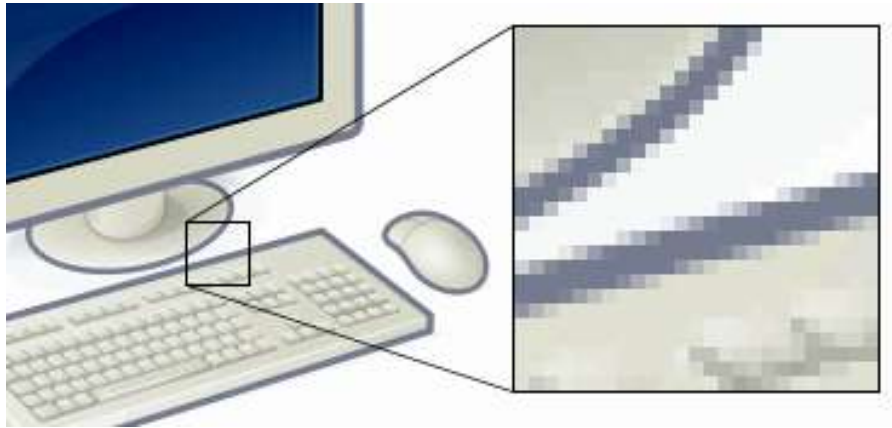


The Intelligent Glasses wereable system





VISUAL – TO – AUDITORY



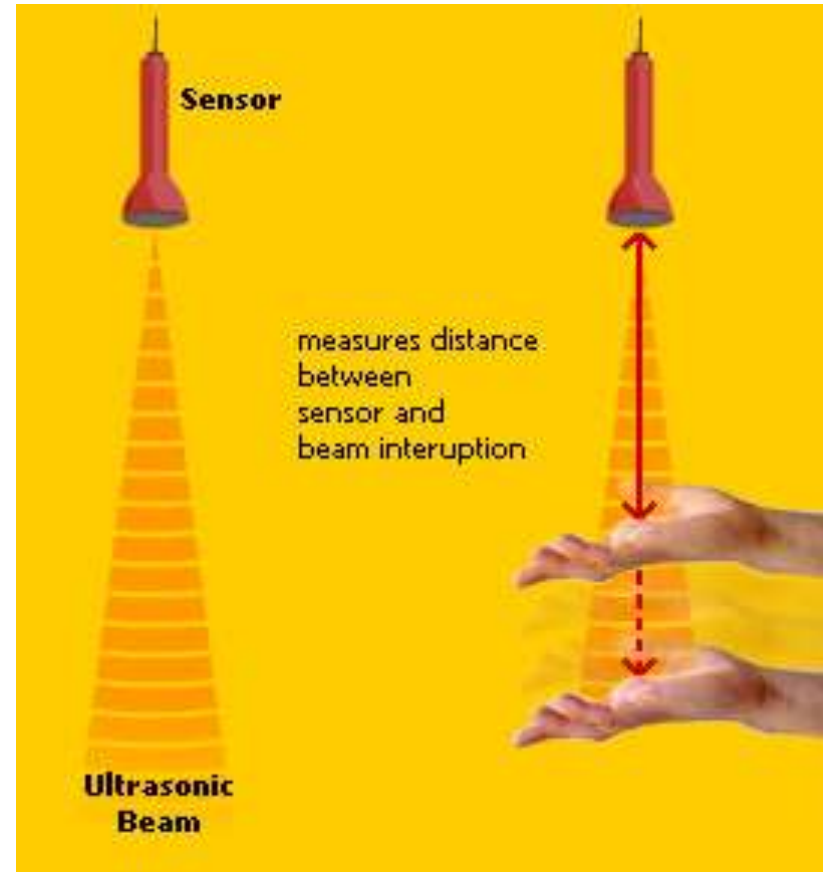
CORE IDEA

Converting pixels in sounds

Electronic Travel Aid for travel assistance.

A laser or ultrasonic beam is emitted in a certain direction in space and the beam is reflected back from objects.

A sensor detects the reflected beam, measures the distance to the object and indicates that information to the user through audio or tactile signals



Head-Mounted Devices (HMDs)

Ultrasonic wide-beam equipment
mounted on spectacle lenses



The SonicGuide 1974

Presence of an obstacle and its
approximate distance to the user



The KASPA system 2002

Creates an auditory representation of
the objects ahead of the user.

The vOICe system

Patented by Philips



Image is translated to sounds where **frequency and loudness** represents different scene information parameters such as position, elevation and brightness.

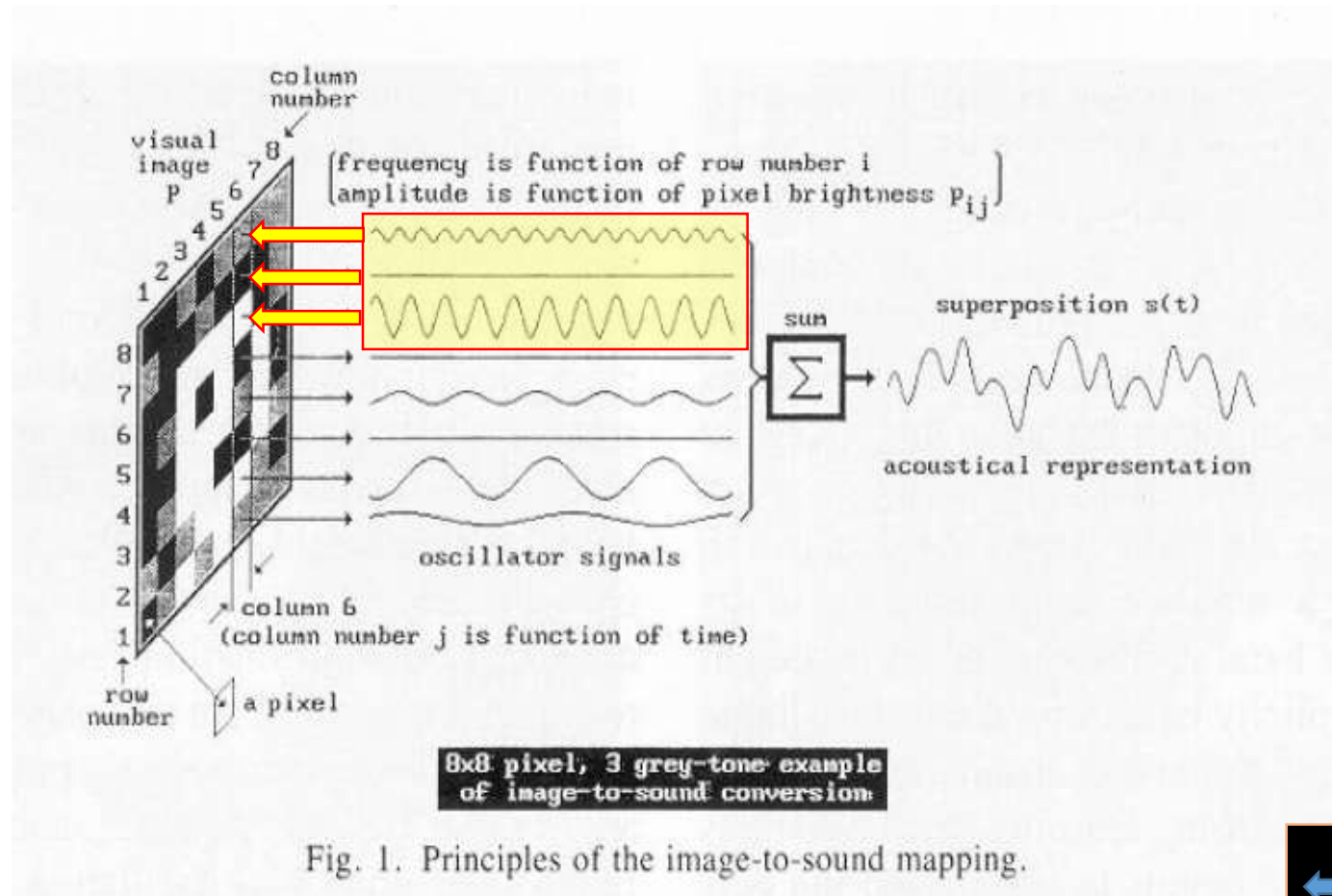
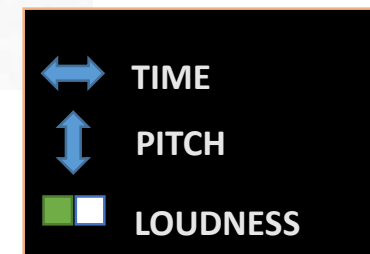


Fig. 1. Principles of the image-to-sound mapping.

64 x 64 pixels image (16 gray-tones per pixel)

1.05-2.10 s time of conversion

Left-to-right processing of columns (16.4-32.8 s)



SUPERIMPOSED SOUND
OF EACH COLUMN



**SEEING WITH THE EARS. HANDS AND BIONIC EYES:
AMIR AMEDI AT TEDXJERUSALEM**



È importante
agire nei primi 3
anni di vita



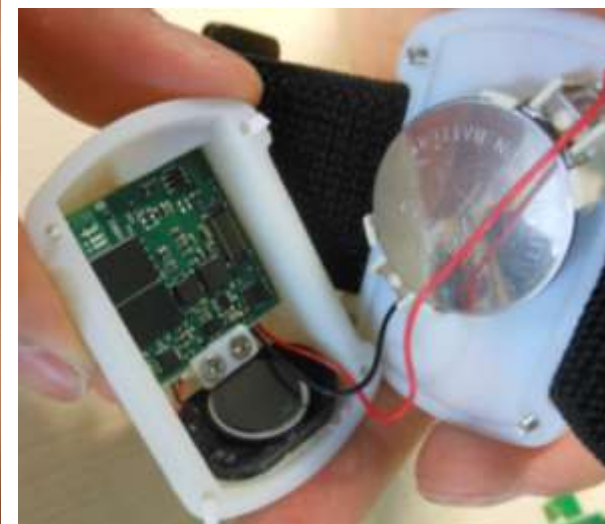
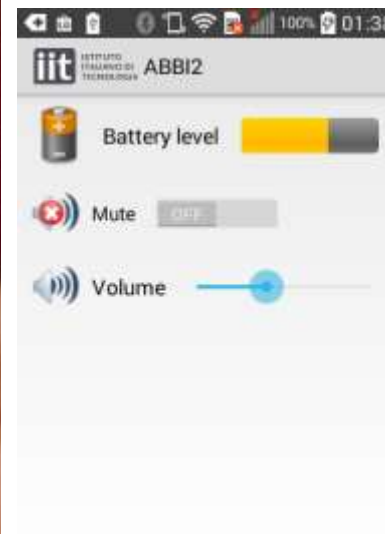


5 mesi bambino vedente





ABBI



DAVID CHIOSSONE ONLUS
PER CIECHI E IPOVEDENTI



UNIVERSITY
of
GLASGOW



LUND
UNIVERSITY



Gabriel Boud-Bovy



ABBI Kit?

risultato finale del progetto ABBI (Abbioproject-LEA), finanziato dall'Unione Europea e nato dall'Istituto Italiano di Tecnologia che ha visto la partecipazione di ricercatori italiani, inglesi, svedesi e tedeschi. Il progetto è nato per tre anni (2014 - 2017) nello sviluppo di un intervento tecnologico per persone con disabilità visiva.

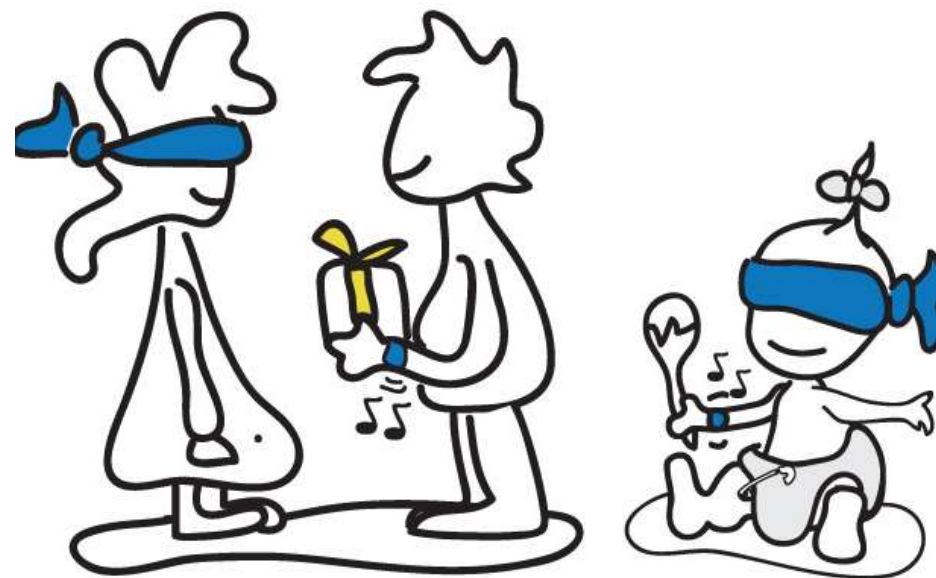
In particolare, ABBI - Kit è un sistema per la diagnosi e la riabilitazione della percezione tattile creato per consentire ai terapisti di svolgere attività educative insieme ai bambini con disabilità e monitorare i loro progressi nello sviluppo delle abilità spaziali.

ai
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te

Vuoi sa



ABBI



Co-Designing



IRIFOR del Trentino Cooperativa Sociale Onlus
Trento, Via della Malvasia 15

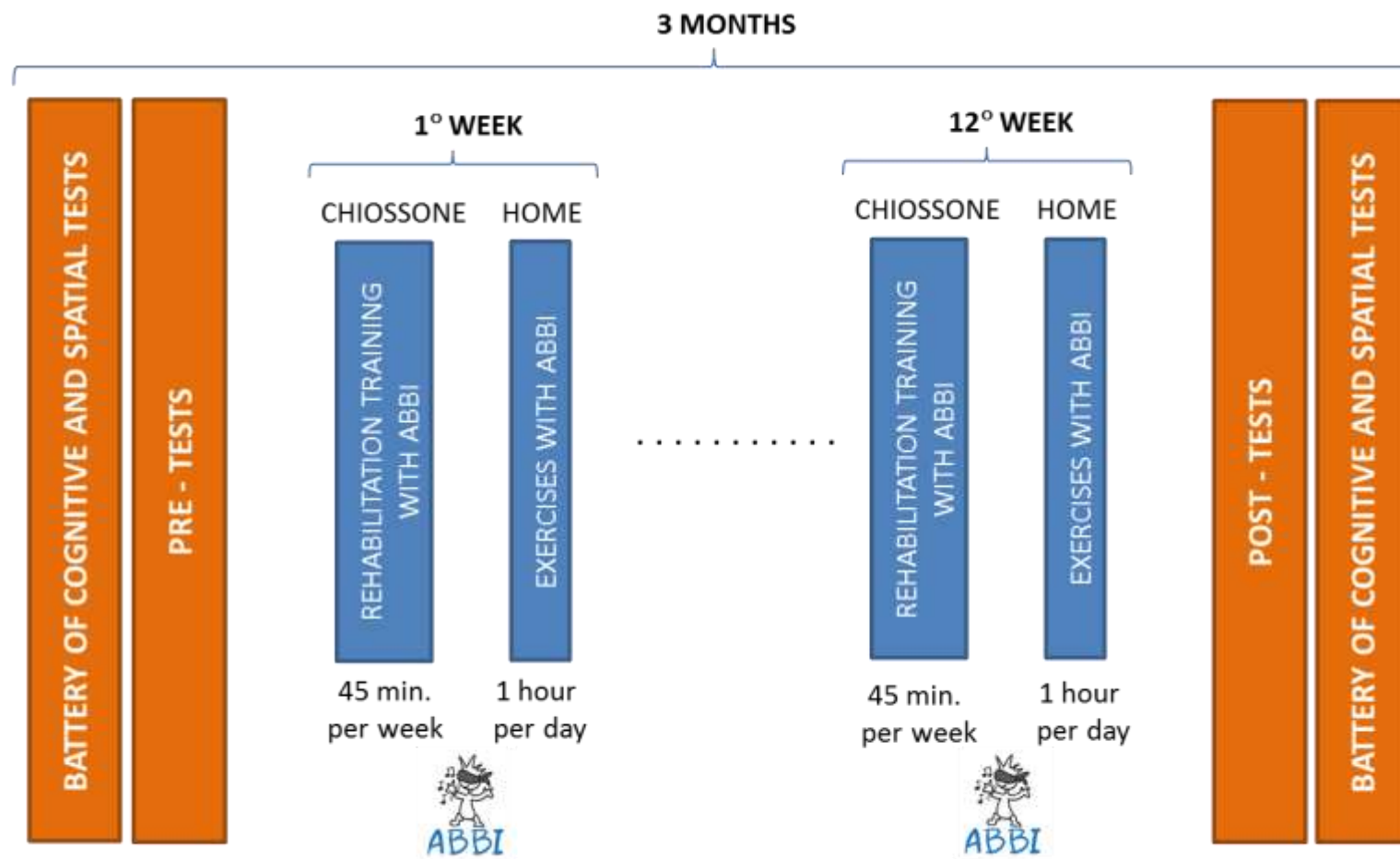
"La Nostra Famiglia", Via Don Luigi
Monza, 20 - 23842 Bosisio Parini (LC)



Elena Cocchi, Elisabetta Capris, Marika Rolando, Paola
Campana, Debora Grammatico, Carla Gilio



Studio longitudinale di 3 mesi in 42 bambini 7-17 anni.



69 hours in 12 weeks



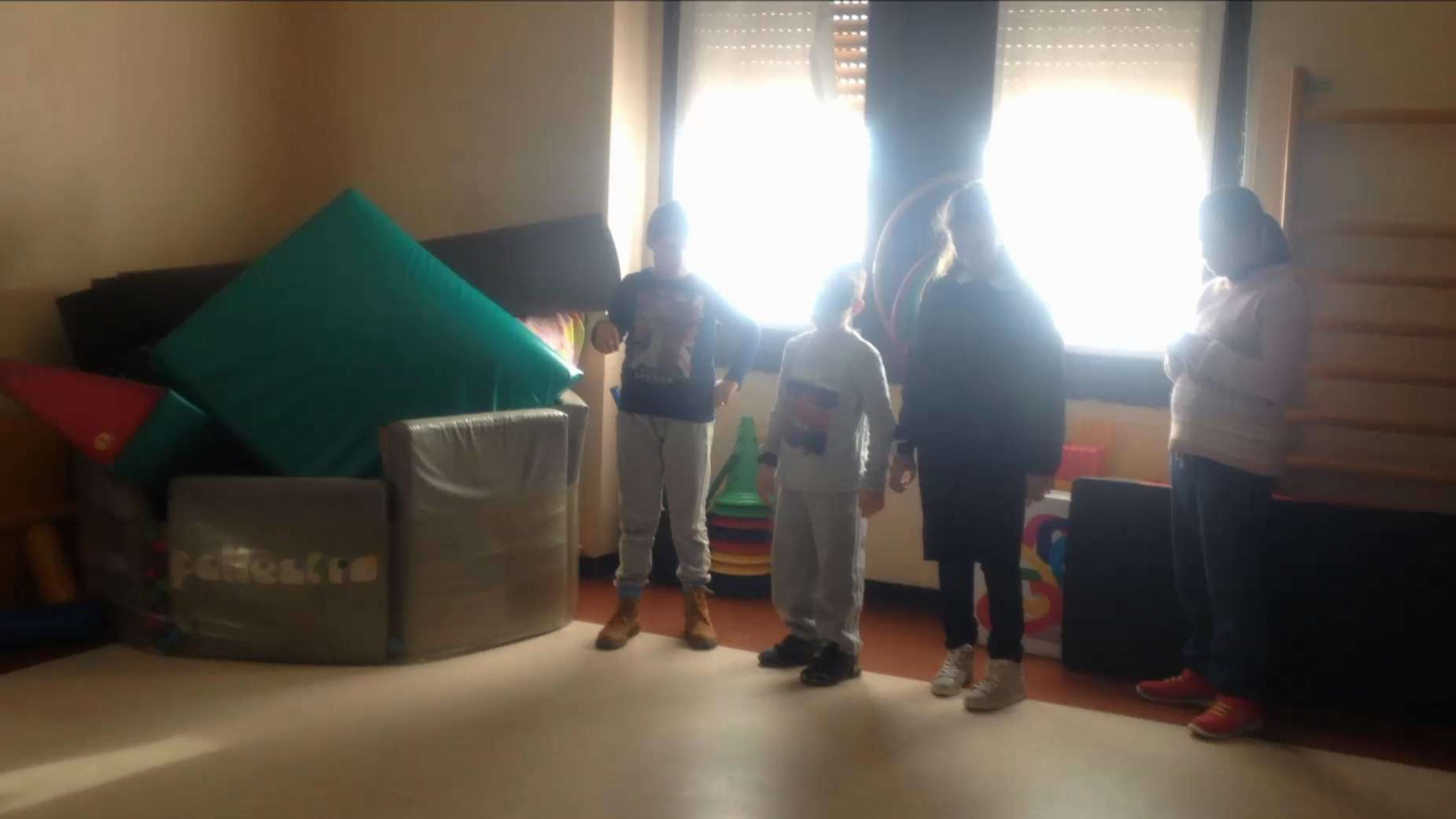
CHIOSSONE
onlus
PER CIECHI E IPOVEDENTI DAL 1868

ASSOCIAZIONE
la Nostra Famiglia















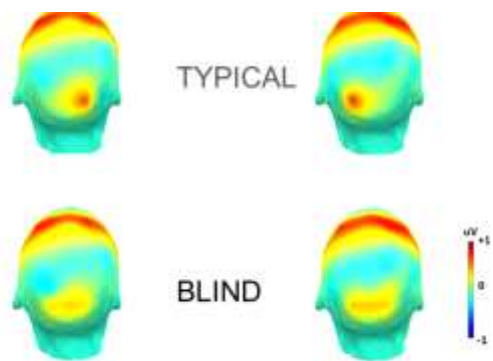
Miglioramento





		PRE TRAINING	POST TRAINING
AUDITORY	Distance		
	Localization (pointing)		
	Localization (walk)		
	Bisection		
MOTOR	Path reproduction (hand)		
	Path reproduction (walk)		
	Go and come test		

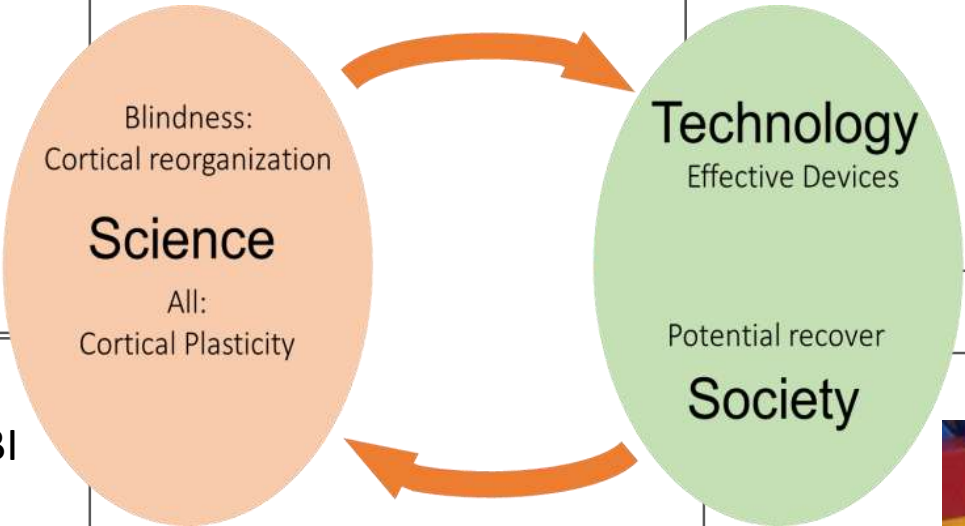
Occipital response to sound in sighted but not in blind individuals



Campus et al. 2017 SREP
Campus et al. 2018 SREP accepted
Amadeo NeuroImage 2018 accepted

ABBI improves spatial, motor and social skills at behavioral level

Medical device: Clinical Trial finalized



Improvement after the use of ABBI

		PRE TRAINING	POST TRAINING
AUDITORY	Distance	✗	✗
	Localization (pointing)	✗	✓
	Localization (walk)	✗	✓
	Bisecton	✗	✓
MOTOR	Path reproduction (hand)	✗	✗
	Path reproduction (walk)	✗	✓
	Go and come test	✗	✓

Cappagli et al. SREP, 2019

Rehabilitation with blind children



Examples of works in 2018
ABBI 3-5 years children: Cappagli et al SREP 2018
ABBI at the foot level: Aggius-Vella et al SREP 2018

From Lab to the Market: Technology Transfer

From ABBI to ABBI-K



AUDIO BRACELET FOR BLIND INTERACTION



AUDIO BRACELET FOR BLIND INTERACTION Kit



Martolini et al. MeMeA 2018 - IEEE

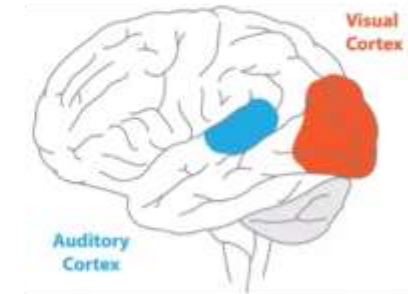
Multisensory integration
Sensory dominance



Prediction on impaired population



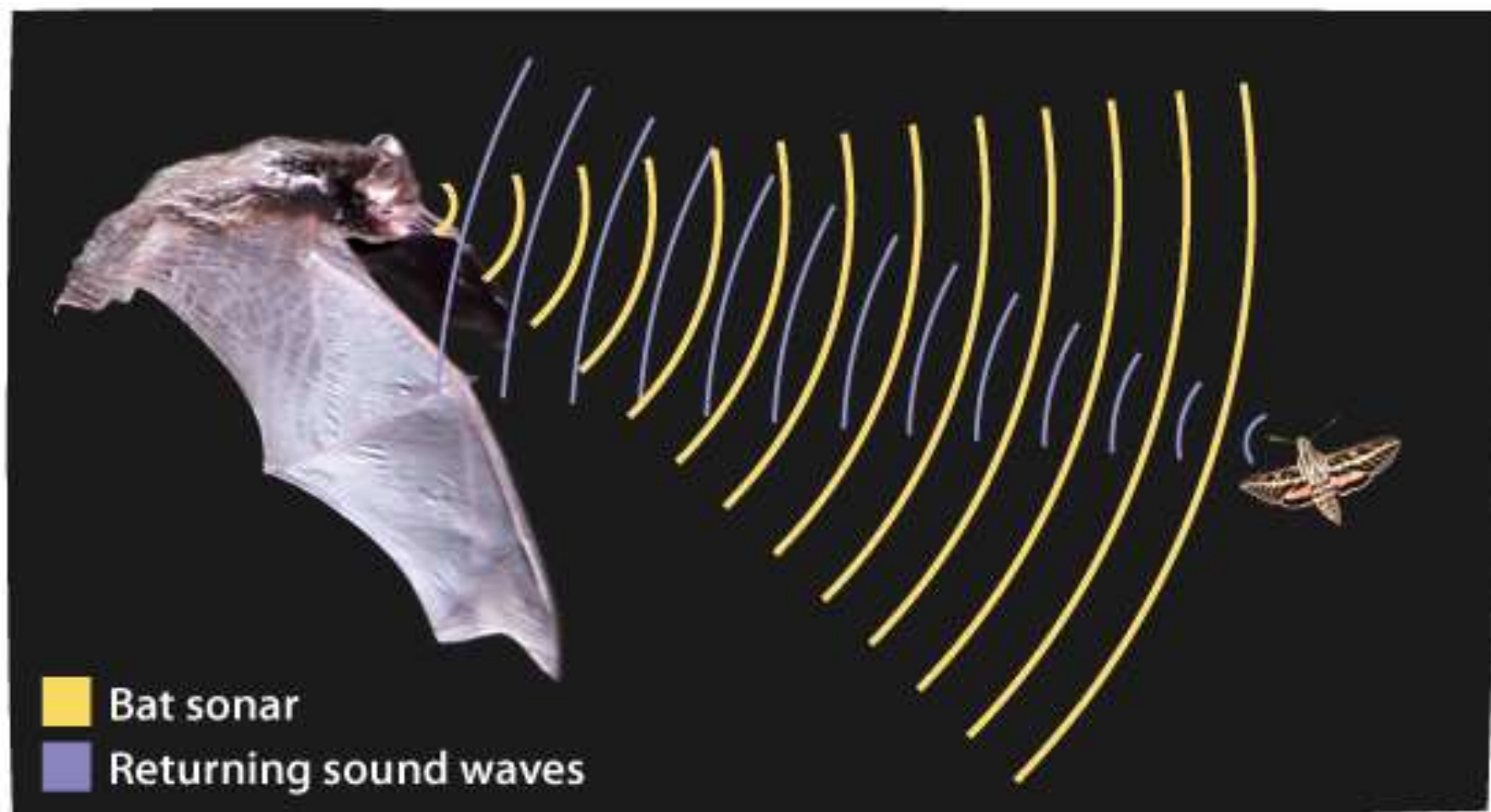
And on cortical mechanisms



ABBI

Echolocation

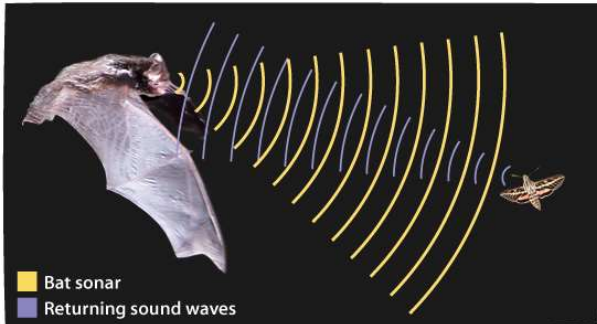




Sonic Eye helmet–cam demonstration video

Supplemental Material for:

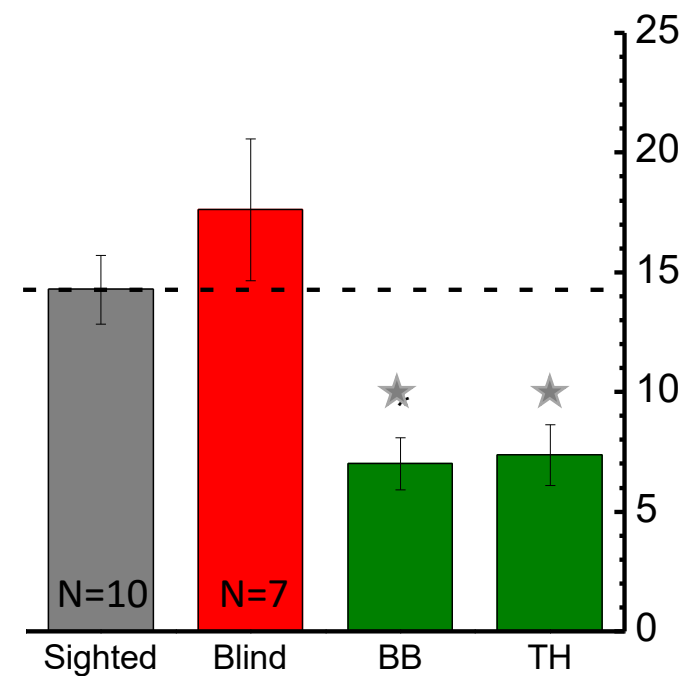
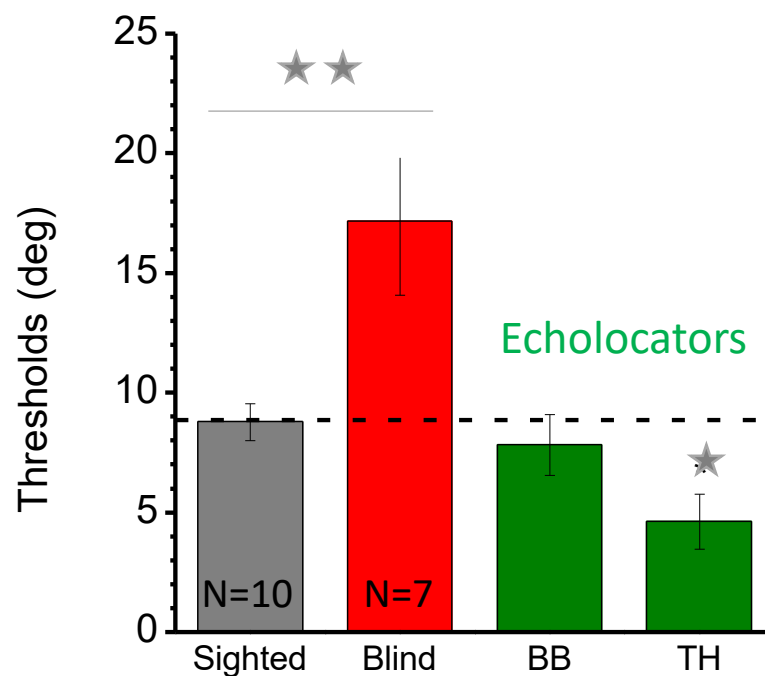
Jascha Sohl-Dickstein, Santani Teng, Benjamin M. Gaub, Chris C. Rodgers, Crystal Li, Michael R. DeWeese, Nicol S. Harper
A device for human ultrasonic echolocation
IEEE Transactions on Biomedical Engineering, 2014



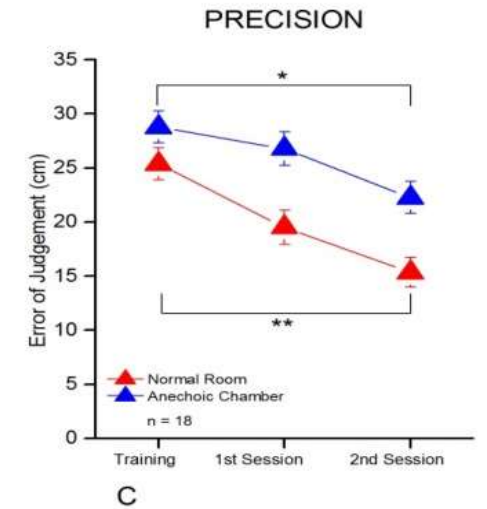
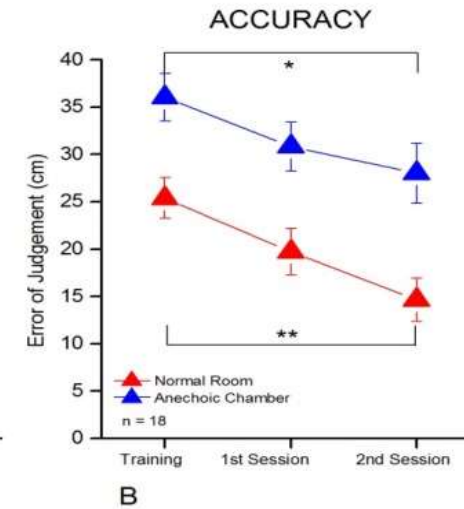
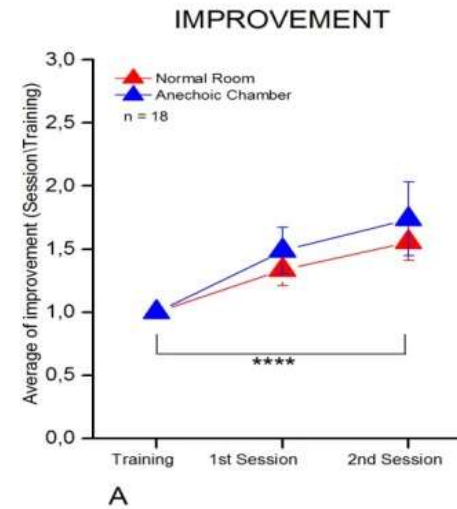
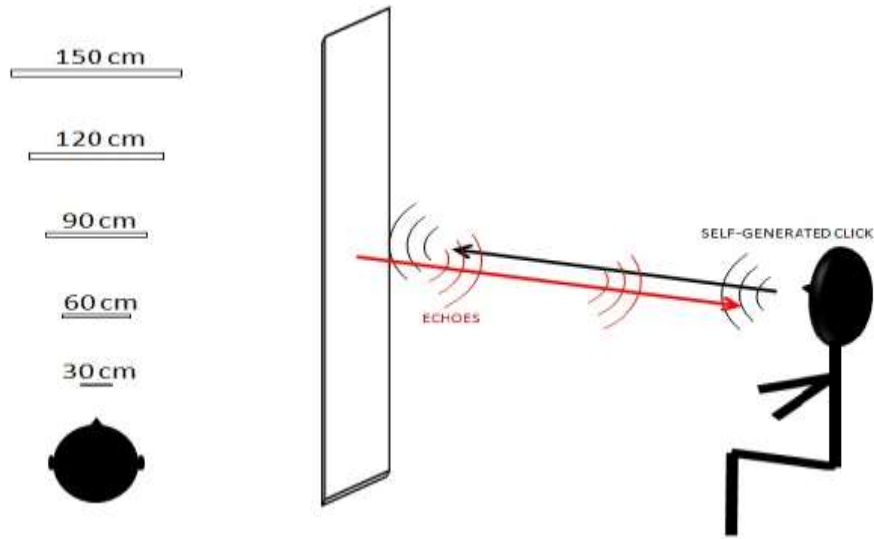
Blind echolocators perform well the audio spatial bisection task

Spatial bisection

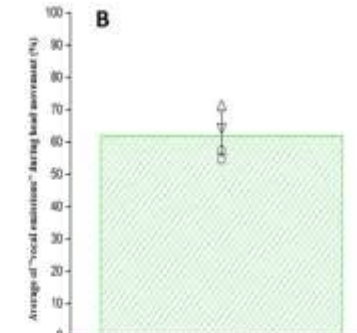
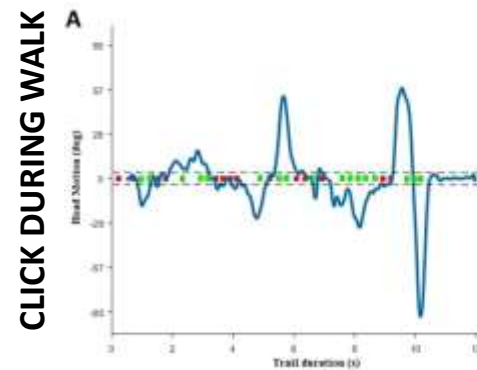
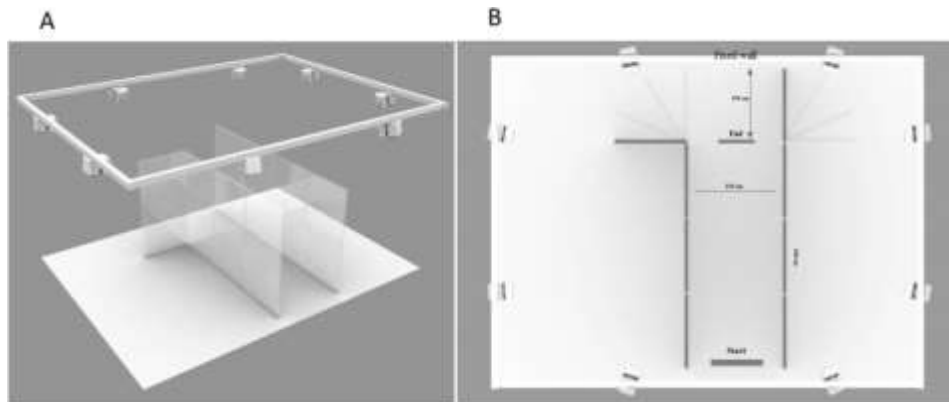
MAA



ECHOLOCATION in sighted individuals



Tonelli, A., Brayda, L., Gori M. *PlosOne*, 2016



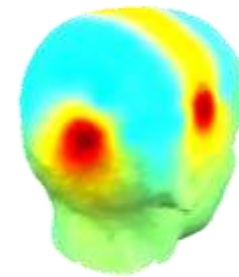
Tonelli, A., Campus, C., Brayda, L. *Scientific Report*, 2018

SPACE BISECTION IN ECHOLOCATORS

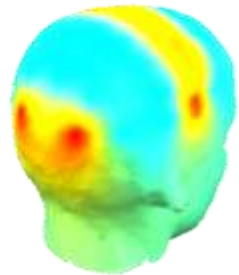
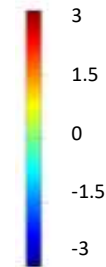
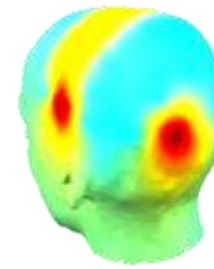


Participants

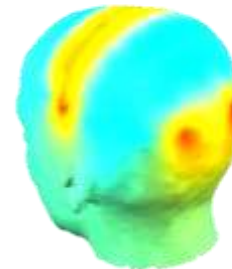
4 CB echolocators
4 CB



Expert
echolocators

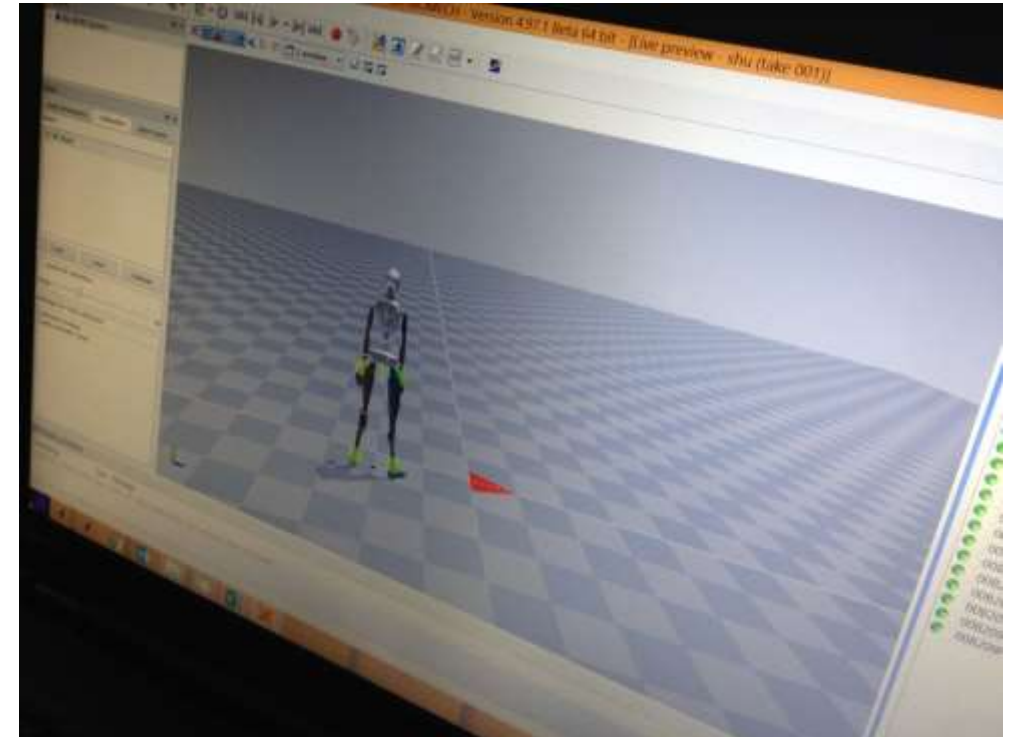


Congenital
blinds

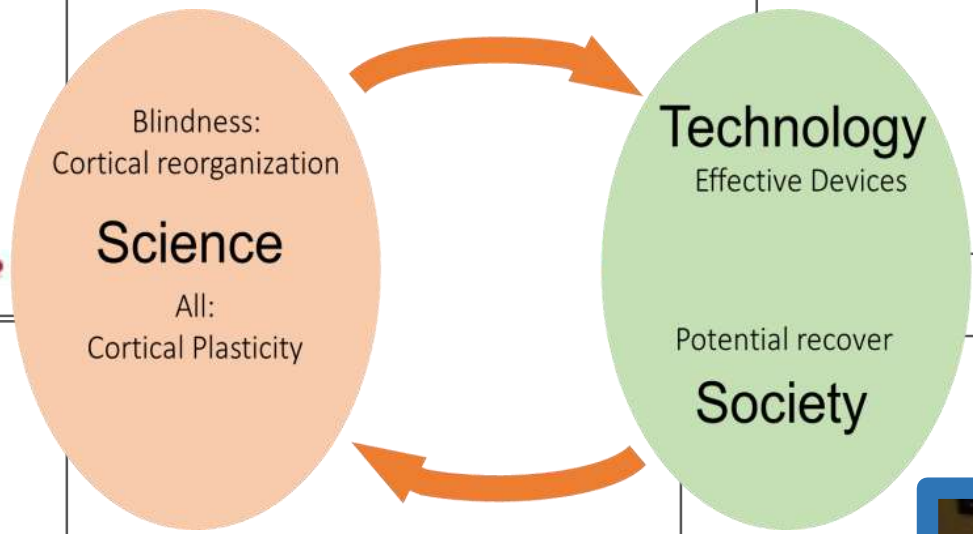
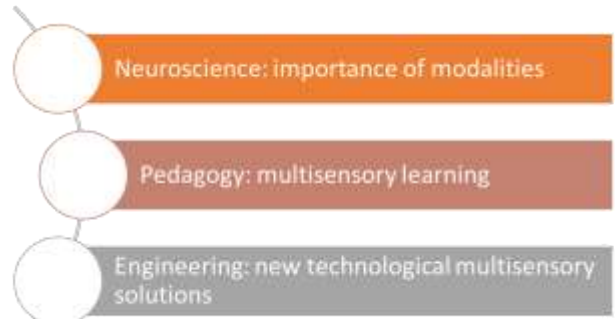




Motion tracking system
Protocol: perform free football activity
Subjects
5 blind football players
5 sighted players
5 sighted players blindfolded



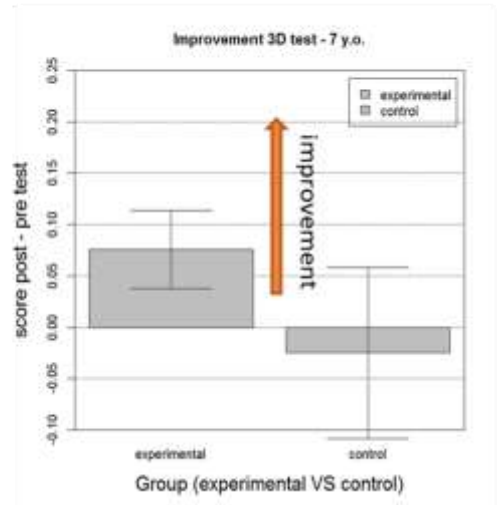
weDRAW: Sensory interactions and Learning at school



Multisensory technology



Improvement after use



Rehabilitation



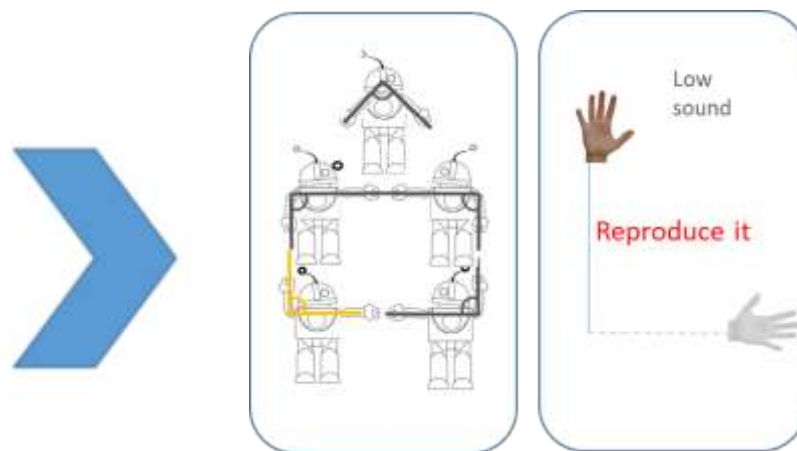
From Lab to the Market: Technology Transfer

Applications for children at school

Kinect + matlab



LIM+ app smartphone/tablet

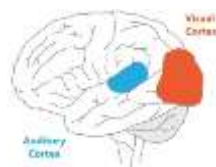


*Applications to be distributed
through the DeA webSite
18000 teachers already users*

Plasticità corticale in assenza di visione



Campus Amadeo



Inuggi

Training riabilitativi per Bimbi non vedenti



Martolini Schiatti Cappagli



Percezione del tempo



Domenici



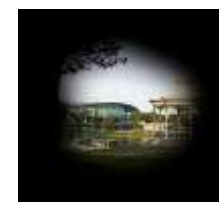
Ecolocazione nella cecità

Tonelli



Training per scotoma

Ahmad



SCIENZA

TECNOLOGIA

SOCIETA'

SCIENZA

Percezione spazio- corpo Realtà virtuale



Esposito



Orientamento e mobilità nel non vedente



Cuturi



Training per la disabilità motoria



Aggius-Vella



Nuovi giochi audio per bimbi non vedenti



Setti



Corpo e Spazio



Bollini

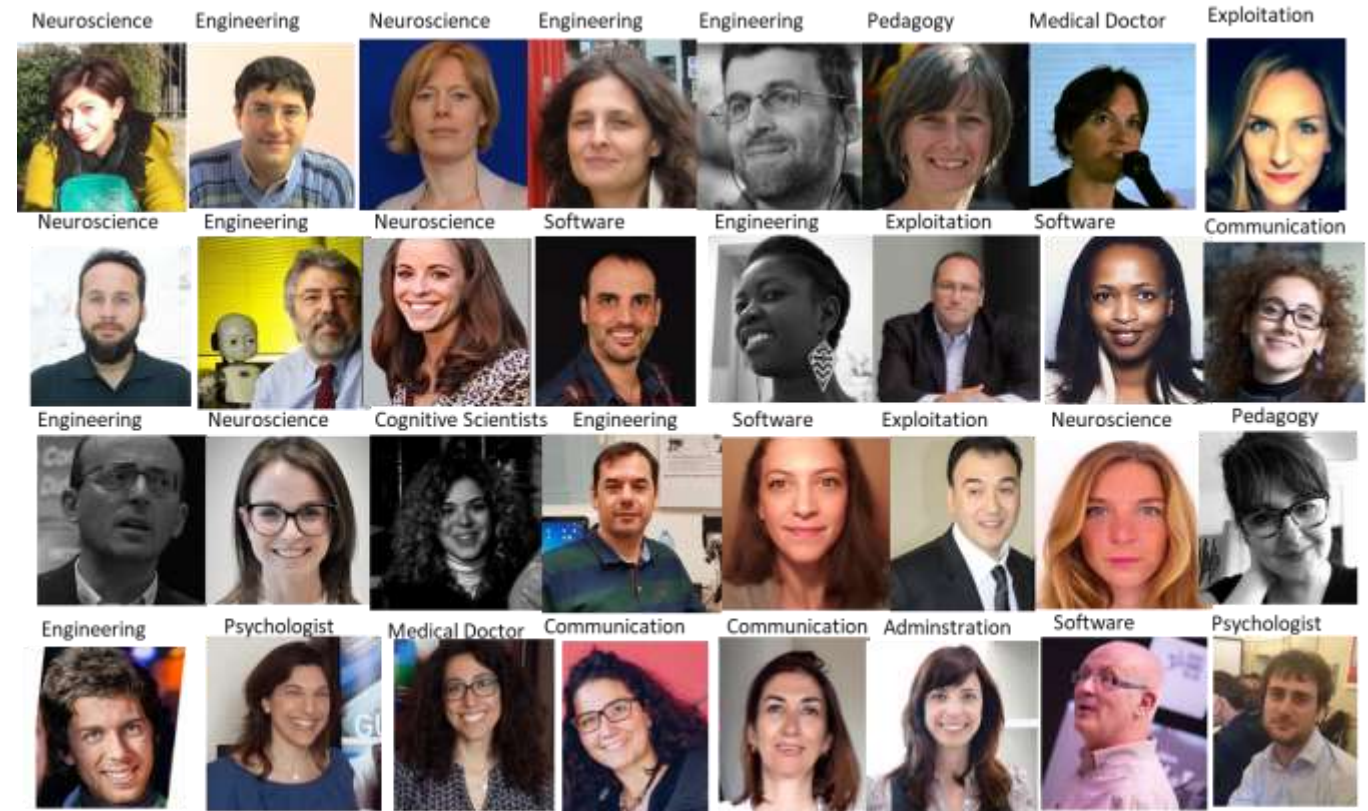


Consorzio

ABBI



WeDRAW



Grazie a tutti i bambini che partecipano ai nostri studi!



Dr. Freddi



Dr. Saviotti

Scuole

- Scuola Don Bosco, Coronata
- International School of Genoa
- Dante Alighieri, Bolzaneto
- Contubernio D'Albertis
- Comprensivo Marassi

Ospedali e centri di riabilitazione

Hospitals



IRCCS
"La Nostra Famiglia", Via Don Luigi
Monza, 20 - 23842 Bosisio Parini (Lc)
IRIFOR del Trentino Cooperativa Sociale Onlus
Trento, Via della Malvasia 15



Associations disability



Schools



Istituto Scolastico Paritario "Contubernio D'Albertis"
Via G. Amarena, 11 - 16143 - Genova

Istituto Comprensivo Bolzaneto
Piazza Rissotto, 2 - 16162 - Genova



Scuola elementare Don Bosco
Via Coronata, 48 - Genova

Other IIT people

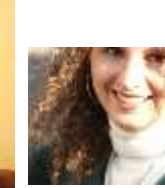
Past collaborators



EDL FACILITY : in particolare



RBCS: in particolare





ISTITUTO ITALIANO
DI TECNOLOGIA
UNIT FOR VISUALLY IMPAIRED PEOPLE

Grazie al
gruppo
U-VIP





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Grazie!

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www.wedraw.eu

www.abbiproject.eu

