BRAINPORT VISION DEVICE

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Statistics on the Blind:

- 37 million: People in the world are blind India (9 million), Africa (7 million) and China (6 million)
- Every 5 seconds: One person in our world goes blind
- 75 million: People will be blind by 2020 (if trends continue)

Cybernetics

- Cybernetics is about having a goal and taking action to achieve that goal.
- "Cybernetics" comes from a Greek word meaning "the art of steering“.
- Ironically but logically, AI and cybernetics have each gone in and out in the search for machine intelligence
- So “I Can Read” can be termed as a “Cybernetics System For Disabled (blind)”

What is Brainport Vision Device?

- "BrainPort device" is a technology developed in US, which is making the world visible to the ones who lose their sight due to some accidental incidents.
- Neuroscientists at Wicab, Inc. has developed the BrainPort Vision Device that allows the blinds to “see” using their tougues.
- Craig Lundberg, 24, is the first British soldier to test the BrainPort system, which is billed as the next best thing to sight.
- The technology has made the dark-dependent world come alive and independent to Craig Lundberg who completely lost his sight after a grenade attack in Iraq, as he is now able to sense the visuals with his tongue. The soldier admits that his world has been transformed because of the technology.
- The device which sends visual input through tongue in much the same way that seeing individuals receive visual input through the eyes is called the “Brainport Vision Device”.
- BrainPort could provide vision-impaired people with limited forms of sight.
- Technically, this device is underlying a principle called “electrotactile stimulation for sensory substitution”.
- To produce tactile vision, BrainPort uses a camera to capture visual data.

ABSTRACT

“BRAINPORT DEVICE”

*The device which sends visual input through tongue in much the same way that seeing individuals receive visual input through the eyes is called the **“Brainport Vision Device”**. BrainPort could provide vision-impaired people with limited forms of sight. To produce tactile vision, BrainPort uses a camera to capture visual data. The optical information -- light that would normally hit the retina -- that the camera picks up is in digital form, and it uses radio signals to send the ones and zeroes to the CPU for encoding. Each set of pixels in the camera's light sensor corresponds to an electrode in the array. The CPU runs a program that turns the camera's electrical information into a spatially encoded signal. The encoded signal represents differences in pixel data as differences in pulse characteristics such as frequency, amplitude and duration. Technically, this device is underlying a principle called **“electrotactile stimulation for sensory substitution”**, an area of study that involves using encoded electric current to represent sensory information and applying that current to the skin, which sends the information to the brain.*

The brain is capable of major reorganization of function at all ages, and for many years following brain damage. It is also capable of adapting to substitute sensory information following sensory loss (blindness; tactile loss in Leprosy; damaged vestibular system due to ototoxicity, or general balance deficit as result of stroke or brain trauma), providing a suitable human-machine interface is used (reviewed in Bach-y-Rita, 1995; in press). One such interface is the tongue BrainPort interface (Bach-y-Rita, et al 1998; Tyler, et al, 2003).

The major objective of this study was to estimate feasibility and efficacy of an electro-tactile vestibular substitution system (ETVSS) in aiding recovery of posture control in patients with bilateral vestibular loss (BVL) during sitting and standing.

Subjects used the BrainPort balance device for a period from 3 to 5 days. Subjects readily perceived both position and motion of a small 'target' stimulus on the tongue display, and

interpreted this information to make corrective postural adjustments, causing the target stimulus to become centered. With two twenty minute sessions a day significant functional improvement lasts the whole day.

1.INTRODUCTION

A blind woman sits in a chair holding a video camera focused on a scientist sitting in front of her. She has a device in her mouth, touching her tongue, and there are wires running from that device to the video camera. The woman has been blind since birth and doesn't really know what a rubber ball looks like, but the scientist is holding one. And when he suddenly rolls it in her direction, she puts out a hand to stop it. The blind woman saw the ball through her tongue. Well, not exactly through her tongue, but the device in her mouth sent visual input through her tongue in much the same way that seeing individuals receive visual input through the eyes. In both cases, the initial sensory input mechanism -- the tongue or the eyes -- sends the visual data to the brain, where that data is processed and interpreted to form images. Braille is a typical example of sensory substitution -- in this case, you're using one sense, touch, to take in information normally intended for another sense, vision. Electrotactile stimulation is a higher-tech method of receiving somewhat similar (although more surprising) results, and it's based on the idea that the brain can interpret sensory information even if it's not provided via the natural channel.

An electric lollipop that allows the blind to ‘see’ using their tongue has been developed by scientists.

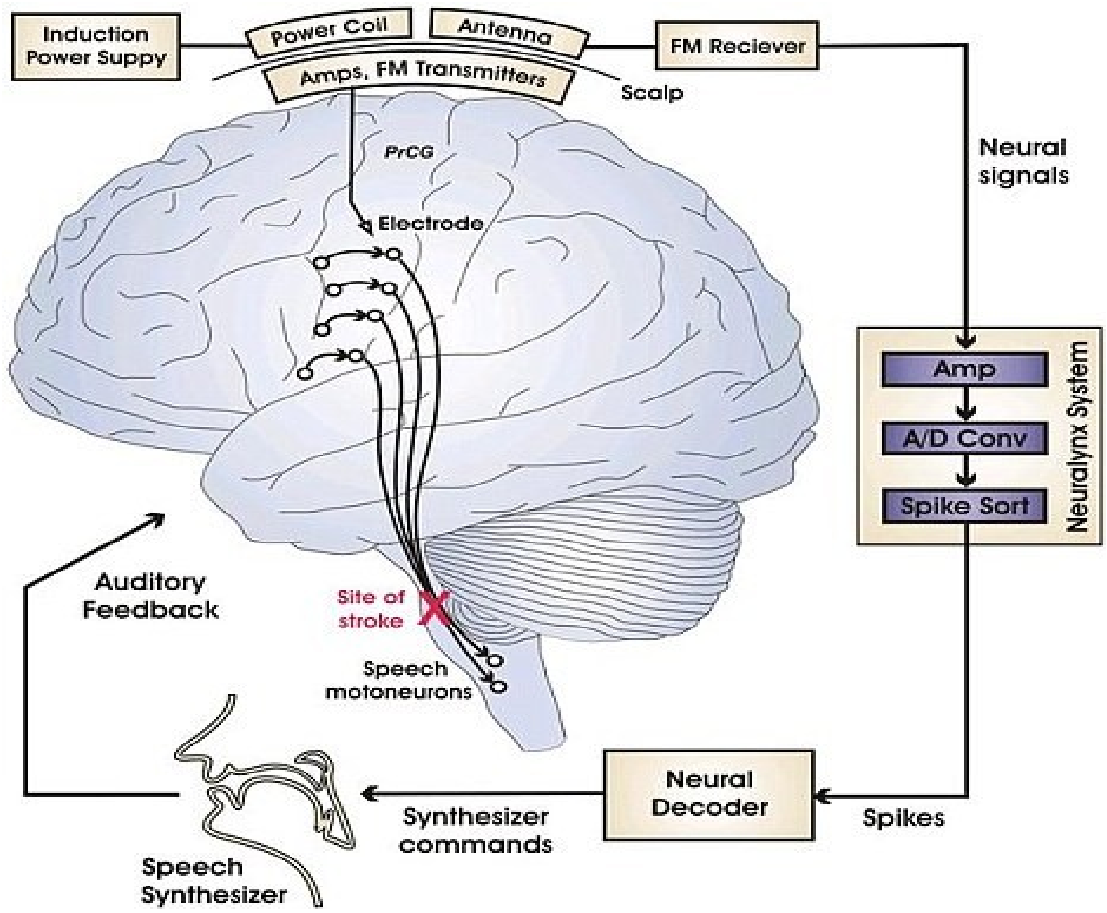
Fig.1 Position of device

The machine is called the Brain Port vision device and is manufactured by Wicab, a biomedical engineering company based in Middleton, Wis. It relies on sensory substitution, the process in which if one sense is damaged, the part of the brain that would normally control that sense can learn to perform another function.

About two million optic nerves are required to transmit visual signals from the retina—the portion of the eye where light information is decoded or translated into nerve pulses—to the brain's primary visual cortex. With Brain Port, the device being developed by neuroscientists at Middleton, Wisc.–based Wicab, Inc. (a company co-founded by the late Back-y-Rita), visual data are collected through a small digital video camera about 1.5 centimeters in diameter that sits in the center of a pair of sunglasses worn by the user. Bypassing the eyes, the data are transmitted to a handheld base unit, which is a little larger than a cell phone. This unit houses such features as zoom control, light settings and shock intensity levels as well as a central processing unit (CPU), which converts the digital signal into electrical pulses—replacing the function of the retina. "Part of the challenge of Brain Port is to train the brain to interpret the information it receives through the stimulation device and use it like data from a natural sense. Research from prototype devices showed such training is possible, as patients with severe bilateral vestibular loss could, after time, maintain near-normal posture control while sitting and walking, even on uneven surfaces.

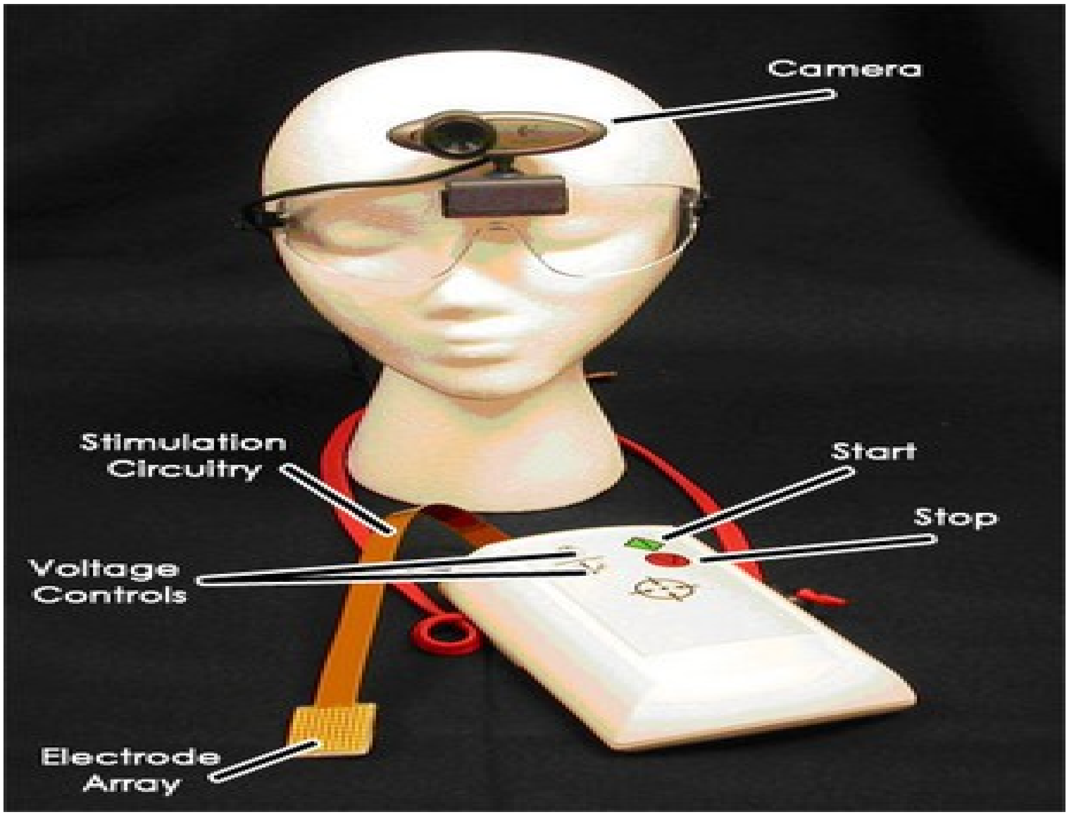
ELECTROTACTILE STIMULATION FOR VISUAL SUBSTITUTION

When a human looks at an object, the optical image entering the eyes does not go beyond the retina. Instead, it would turn into spatio-temporal nerve patterns of impulse along the optic nerve fibres. By analysing the impulse patterns, the brain recreates the images. Indeed, the channels such as eyes, ears and skin those carry sensory information to the brain are set up in a similar manner to perform similar activities. To substitute one sensory input channel for another, the big challenge to the scientists is how to correctly encode the nerve signals for the sensory event and send them to the brain through the alternate channel as the brain appears to the flexible when it comes to interpreting sensory input. The concepts at work behind electrotactile stimulation for sensory substitution are complex. The idea is to communicate non-tactile via electrical stimulation of the sense of touch. In practice, this typically means that "an array of electrodes receiving input from a non- tactile information source (a camera, for instance) applies small, controlled, painless currents (some subjects report it feeling something like soda bubbles) to the skin at precise locations according to an encoded pattern." For a blind person, it means the encoding of the electrical pattern essentially attempts to mimic the input that would normally be received by the non-functioning sense – vision. So patterns of light picked up by a camera to form an image are replacing the perception of the eyes and converted into electrical pulses that represent those patterns of light. In other words, when the encoded
pulses are applied to the skin, the skin is actually receiving image data which would be then sent to the brain in the forms of impulse. Under normal circumstances, the parietal lobe in the brain receives touch information, while the occipital lobe receives vision information. When the nerve fibers forward the image-encoded touch signals to the parietal lobe, "the electric field thus generated in subcutaneous tissue directly excites the afferent nerve fibers responsible for touch sensations". Within the system, arrays of electrodes can be used to communicate
non-touch information through pathways to the brain normally used for the touch related impulses. The breakthrough of the BrainPort technology is to use the tongue as the substitute sensory channel.



THE STRUCTURE OF THE BRAINPORT DEVICE:

The figure below shows the structure of the BrainPort Vision Device.



The optical information that would normally hit the retina is picked up by the digital camera in digital form. It uses radio signals to send the ones and zeros to the CPU for encoding. Each set of pixels in the camera's light sensor corresponds to an electrode in the array. After that, the CPU runs a program that turns the camera's electrical information into a spatially encoded signal.

"The encoded signal represents differences in pixel data as differences in pulse characteristics such as frequency, amplitude and duration. Multidimensional image information takes the form of variances in pulse current or voltage, pulse duration, intervals between pulses and the number of pulses in a burst, among other parameters."

Then, the electrode array (shown in Fig) receives the resulting signal via the stimulation circuitry and applies it to the tongue. At last, the brain interprets and uses the information coming from the tongue as if it were coming from the eyes.

BACKGROUND

Brain Port is a technology sold by *Wicab Inc*. whereby sensory information can be sent to one's brain via a signal from the Brain Port (and its associated sensor) that terminates in an electrode array which sits atop the tongue. It was initially developed by Paul-Bach-y-Rita as an aid to people's sense of balance, particularly of stroke victims. Bach-y-Rita founded *Wicab* in 1998.

The Brain Port vision device was developed by the late Dr. Paul Bach-y-Rita, a University of Wisconsin-Madison neuroscientist. The technology is covered by patents held by the Wisconsin Alumni Research Foundation ("WARF") and is exclusively licensed to Wicab. The Brain Port vision device is currently an investigational device and is not available for sale. Wicab Inc. is pursuing additional funding to support FDA clearance and commercialization.

The machine is called the Brain Port vision device and is manufactured by Wicab; a biomedical engineering company based in Middleton, the device being developed by neuroscientists at Middleton, Wisc.–based Wicab, Inc. (a company co-founded by the late Back-y-Rita), the brain port device will be introduced in 2006. Brain Port collects visual data using a tiny, glasses-mounted video camera, translating images into electrical patterns on the surface of the tongue.

After a few hours of training, some users have described the experience as resembling a low-resolution version of the vision they once had. In addition, neuroimaging research suggests that for blind individuals, visual regions of the brain are activated while using the Brain Port vision device. Ultimately, the experience is uniquely individual. However, the resulting perception does not need to "feel" like eye-based vision in order to provide assistive benefit.

The Brain Port vision device is an investigational non-surgical assistive visual prosthetic device that translates information from a digital video camera to your tongue, through gentle electrical stimulation.

3. RESEARCH WORK

The brain is capable of major reorganization of function at all ages, and for many years following brain damage. It is also capable of adapting to substitute sensory information following sensory loss (blindness; tactile loss in Leprosy; damaged vestibular system due to ototoxicity, or general balance deficit as result of stroke or brain trauma), providing a suitable human-machine interface is used (reviewed in Bach-y-Rita, 1995; in press). One such interface is the tongue Brain Port interface (Bach-y-Rita, et al 1998; Tyler, et al, 2003). Sensory substitution allows studies of the mechanisms of late brain plasticity, in addition to offering the possibility of practical solutions for persons with major sensory loss. It also offers the opportunity to study brain imaging correlates of the perceptual learning with the substitute system, such as PET scan studies demonstrating that the visual cortex of congenitally blind persons reveals activity after a few hours of vision substitution training; (Ptito, et al, 2005). In this report tactile vision substitution (TVSS) will be briefly reviewed, followed by a more extensive discussion of electro tactile vestibular substitution. (ETVSS) which will include a personal report by a subject. Some mechanisms related to the therapeutic effects will be presented, followed by a brief presentation of another area of therapeutic applications of late brain plasticity

The TDU is the first prototype of the technology that has evolved into today's Brain Port vision device. The current investigational prototype works best for individuals who are blind and have no better than light perception. Since we do not stimulate the eye or optic nerve, our technology has the potential to work across a wide range of visual impairments. We are actively developing device modifications to address the needs for those with low vision such as macular degeneration.

In Case of Brain damage: The brain is capable of major reorganization even many years after an injury, with appropriate rehabilitation. The highly plastic brain responds best when the therapy is motivating and has a benefit that is recognized by the patient. The major objective of this study was to estimate feasibility and efficacy of an electro-tactile vestibular substitution system (ETVSS) in aiding recovery of posture control in patients with bilateral vestibular loss (BVL) during sitting and standing. Subjects used the Brain Port balance device for a period from 3 to 5 days.

Other than normal use of tongue for tasting food, eating, talking there are also many other uses. One of them is for sensing of light. It is called as tasting because it can taste the light and sense the objects. It is this property which is used in brain port device.

3.1 PARTS OF DEVICE:

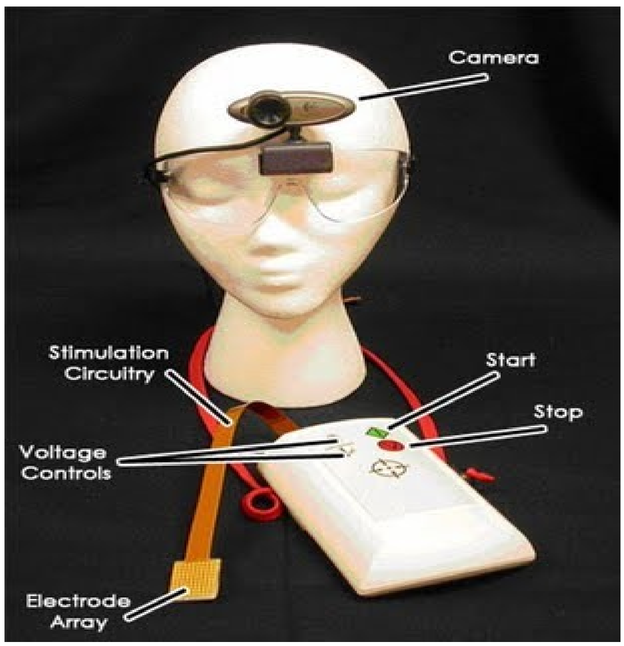


Fig. 3.1parts of brain port device

1 — Camera on the forehead captures the image of test symbol.
2 — Video output is sent to a processor.
3 — Processor translates output from camera into a pattern of electronic pulses that are sent to an array of electrodes held against the tongue.
4 — Array of electrodes a little over an inch square stimulate receptor cells on the surface of the tongue to the Brain i.e., Tactile or touch receptors on the tongue send impulses to the somatasensory cortex in response to stimulation.

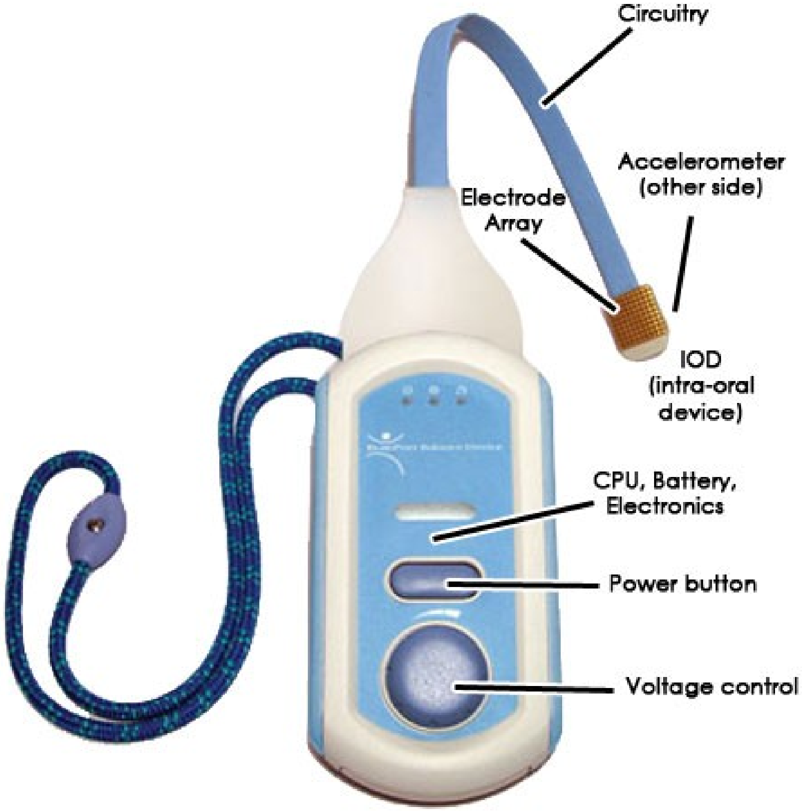


Fig.3.2 Parts of lollipop

INTRA ORAL DEVICE (LOLLIPOP): It consists of three parts

THE BRAIN PORT BALANCE DEVICE:

The Brain Port balance device consists of an Intra Oral Device (IOD) and a Controller. The IOD contains an embedded accelerometer and an electrode array. The electrode array rests on the anterior surface of the patient's tongue and the accelerometer is used to measure head/body position. Using these measurements, a stimulus pattern is generated on the electrode array reflecting the head/body position. The patient feels the pattern as electro tactile stimulation on the tongue. For example, if a patient leans to the left, the stimulus moves to the left side of the patient's tongue; a forward lean moves the stimulus to the front of the tongue. During training, patients are instructed to focus on the stimulus and to adjust their body position to keep the stimulus centered on their tongue. The Controller provides user controls for power, stimulation intensity, and re-centering the stimulus on the electrode array.

Assessments: Subjects were assessed at baseline and at pre-determined points during the study as determined by the individual investigators. Subjects did not use the Brain Port device during the assessments. Each clinical site did not necessarily administer all assessments, resulting in a smaller number of subjects for individual measurements. Changes in balance were measured using the following objective and clinically accepted standardized outcome measures:

- Computerized Dynamic Posturographic Sensory Organization Test (SOT)
- Dynamic Gait Index (DGI)
- Activities-specific Balance Confidence (ABC) Scale
- Dizziness Handicap Inventory (DHI)

3.1.1 ELECTRODE ARRAY:

Fig.3.3electrode array which is placed on tongue

Fig.3.4 top view of electrode array

The lollipop contains a square grid of 400 electrodes which pulse according to how much light is in that area of the picture. White pixels have a strong pulse while black pixels give no signal. The control unit converts the image into a low resolution black, white and grey picture, which is then recreated as a square grid of 400 electrodes – around the size of a postage stamp – on the lollipop. Each of the electrodes pulses according to how much light is in that area of the picture. It converts pictures into electrical pulses and it is placed on tongue.

Fig.3.5 Electrode device

3.1.2. STIMULATION CIRCUITRY

A programming device comprising: a user interface; and a processor that presents a user with an interface for selection of one of a constant current mode or a constant voltage mode via the user interface, receives a selection of one of the modes from the user via the user interface, configures a medical device according to the selected mode, and presents the user with either an interface for selection of a voltage amplitude or an interface for selection of a current amplitude via the user interface based on the selected mode, wherein the processor configures the medical device to measure, using impedance measurement circuitry, an impedance presented to stimulation circuitry of the medical device based on the selected mode, and wherein, when the medical device comprises constant current stimulation circuitry and the user selects the constant voltage mode, the processor configures the medical device to measure, using the impedance measurement circuitry, the presented impedance and adjust a stimulation current amplitude based on the measured impedance to deliver stimulation with a substantially constant voltage amplitude.

3.1.3. ACCELEROMETER

The other side of electrode array is accelerometer. Named Brain Port, and developed by Wicab, Inc, this experimental device uses an accelerometer to provide head and body position information to the brain through electro tactile stimulation of the tongue. Sensitive nerve fibers on the tongue respond to electrodes to enable a rapid transfer of electrical information.

- **sunglasses and camera**

The device is made up of a video camera hidden in a pair of sunglasses, which the user wears. Signals from the camera are sent along a cable to a handheld control unit, about the size of a cell phone, and then to a lollipop-shaped stick, which is placed on the tongue. The inventors claim that blind people using the device, that look like sunglasses attached by cable to a plastic lollipop, blind people can make out shapes and read signs with less than 20 hours training. The Brain Port device collects visual data through a small digital video camera about 1.5 centimeters in diameter that sits in the middle of a pair of sunglasses worn by the user.

- **CPU,BATTERY**

This unit houses such features as zoom control, light settings and shock intensity levels as well as a central processing unit (CPU), which converts the digital signal into electrical pulses—replacing the function of the retina. It will be a rechargeable battery

- **POWER BUTTON**

It is used for start and stops.

3.2 WORKING OF BRAIN PORT:

- About two million optic nerves are required to transmit visual signals from the retina—the portion of the eye where light information is decoded or translated into nerve pulses—to the brain's primary visual cortex.
- Visual data are collected through a small digital video camera. Bypassing the eyes, the data are transmitted to a handheld base unit, which is a little larger than a cell phone.

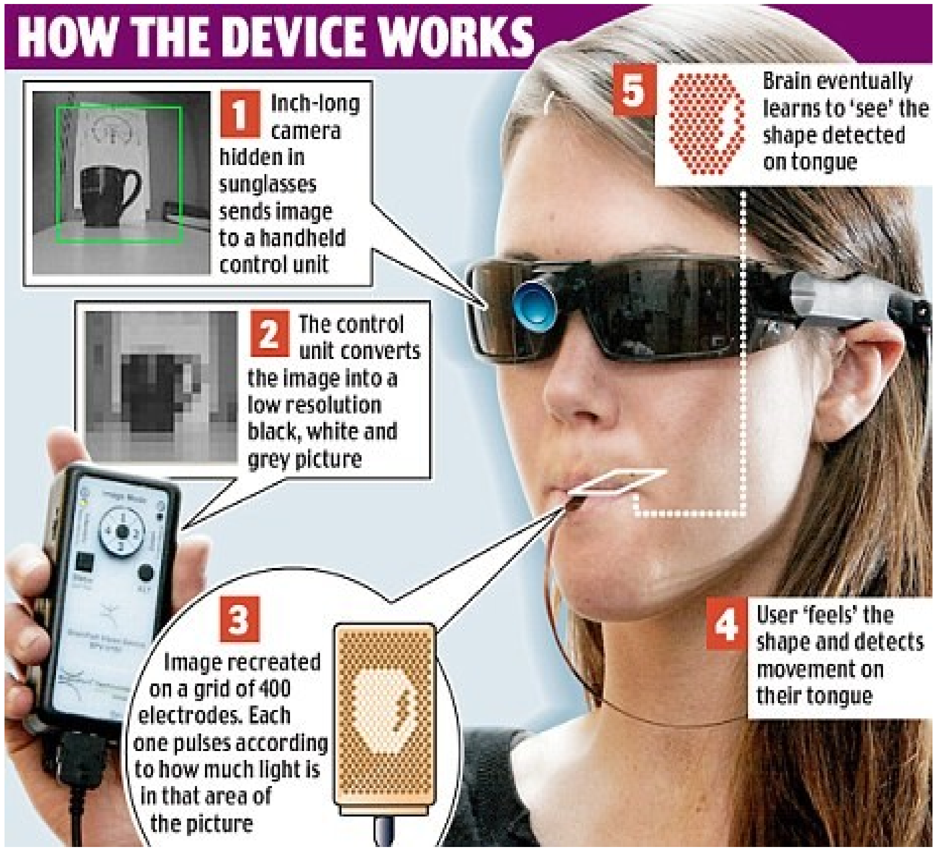


Fig.3.6 working of brain port device

- From the CPU, the signals are sent to the tongue via a "lollipop," an electrode array about nine square centimeters that sits directly on the tongue.
- Densely packed nerves at the tongue surface receive the incoming electrical signals, which feel a little like Pop Rocks or champagne bubbles to the user.
- These signals from tactile or touch receptors cells are sent to the somatasensory cortex in response to stimulation in the form of pattern impulses.

- Although users initially 'feel' the image on their tongue, with practice the signals activate the 'visual' parts of the brain for some people.
- In any case, within 15 minutes of using the device, blind people can begin interpreting spatial information via the Brain Port.

The Brain Port vision system consists of a postage-stamp-size electrode array for the top surface of the tongue (the tongue array), a base unit, a digital video camera, and a hand-held controller for zoom and contrast inversion. Visual information is collected from the user-adjustable head-mounted camera (FOV range 3–90 degrees) and sent to the Brain Port base unit. The base unit translates the visual information into an stimulation pattern that is displayed on the tongue. The tactile image is created by presenting white pixels from the camera as strong stimulation, black pixels as no stimulation, and gray levels as medium levels of stimulation, with the ability to invert contrast when appropriate. Users often report the sensation as pictures are painted on the tongue with Champagne bubbles.

With the current system (arrays containing 100 to 600+ electrodes), study participants have been able to recognize high-contrast objects, their location, movement, and some aspects of perspective and depth. Trained blind participants use information from the tongue display to augment understanding of the environment. Our ongoing research with the Brain Port vision device demonstrates the great potential of tactile vision augmentation and we believe that these findings warrant further exploration. As a result, we are currently working on improvements to the tongue display hardware, software, and usability, and on overall device miniaturization.

The system includes the following: A miniature 2-axis accelerometer (Analog Devices ADXL202) was mounted on a low-mass plastic hard hat Anterior-posterior and medial-lateral angular displacement data (derived by double integration of th acceleration data) were fed to a previously developed tongue display unit (TDU) that generates a patterned stimulus on a 100 or 144-point electro tactile array (10x10 or 12 x 12 matrix of 1.8 mm diameter gold-plated electrodes on 2.3 mm centers) held against the superior, anterior surface of the tongue. Subjects readily perceived both position and motion of a small 'target' stimulus on the tongue display, and interpreted this information to make corrective postural adjustments, causing the target stimulus to become centered. Thirty nine research subjects used the Brain Port balance device for a period from 3 to 5 days. The subjects included 19 males and 20 females ranging in age from 25 to 78 years, wit an average age of 55 years. Etiologies of the balance disorders included, but were not limited, to peripheral vestibular disorders, central vestibular disorders, cerebella disorders and mixed etiology. We found two groups of ETVSS effects on BVL subjects: immediate and residual. After a short (15-40 minutes) training procedure all subjects were capable of maintaining vertical posture with closed eyes, and after additional training (30-160 minutes) some were capable of standing with closed eyes on a

Short-term after-effects were observed in sitting subjects after 1-5 minutes of ETVSS Exposure and lasted from 30 sec to 3 minutes, respectively.

Long-term after-effects were observed in trained subjects (after an average 5 training sessions) after 20 minutes standing with eyes closed and ETVSS use, with stability lasting from 4 to 12 hours, as measured by standard posture graphic techniques and spectral analysis. Additionally, during that period subjects also experienced dramatic improvement in balance control during walking on uneven or soft surfaces, or even riding a bicycle.

Persisting effects were demonstrated in one subject after 40 training sessions and continued for 8 weeks after the last ETVSS session. Evaluation of the results and previous studies suggests that a small amount of surviving vestibular sensory tissue can be reorganized; previous studies suggest that as little as 2 percent of surviving neural tissue in a system can serve as the basis for functional reorganization .

Why device should be placed on TONGUE

Fig.3.7 position of electrode array on tongue

- Other parts of the body, such as the back, were not sufficiently sensitive. The fingertips were sensitive enough, but people wanted full use of their hands to grip a cane or to grab objects.

- Placing the device on the tongue inside the mouth, frees the hands to interact with environment, Plus, the device can be hidden in the mouth.

- The key to the device may be its utilization of the tongue, which seems to be an ideal organ for sensing electrical current. Saliva there functions as a good conductor.

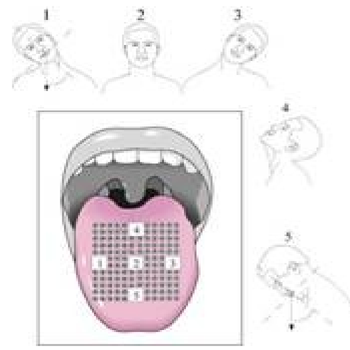


Fig.3.8 exact location of electrode array on tongue

Also it might help that the tongue's nerve fibers are densely packaged and that these fibers are closer to

- The tongue's surface relative to other touch organs. (The surfaces of fingers, for example, are covered with a layer of dead cells called stratum corneum.)
- The tongue was the ideal place to provide information through tactile stimulation. There is a high level of nerve endings in the tongue, similar to a finger. And the tongue is constantly moist, so there is constant electric conductivity.
- Finger would require 10 times more electric stimulation than the tongue does to produce the same results in the visual cortex.
- The tough is more sensitive than other skin area ---the nerve fibers are closer to the surface
- It requiersless voltage to stimulator nerve fiber in the tongue because in other parts an outer layer of dead skin cells to act as an insulator—5 to15 volts compared to 40 to 500 volts for areas like the fingertips or abdomen
- Saliva contains electrolytes, free ions that acts as electrical conductors, so it helps maintain the flow of current between the electrode and the skin tissue

3.3 BRAIN AND COMPUTER INTERFACE:

Camera to CPU

- camera captures the image of test symbol and sent to a processor i.e. handled unit about size of cell phone
- CPU translates camera output in to a pattern of electronic pulses & sent to electrode array which is held against the tongue

CPU to tongue

- Array electrode stimulate receptor cells (tactile/touch) on the surface of the tongue With practice in use signals activate visual part of brain.

- tongue to brain

- these signals from tactile or touch receptors cells are sent to the somatasensory cortex in response to stimulation in the form of pattern impulses

- With practice in use signals activate visual part of brain.

  "Tongue creates sight for blind: Visually impaired persons will be able to use device to sense images on tongue"

Brain–computer interface:

Technologies : Biomechatronics, Brainimpant , implant,BrainGate, Brain port Cyberware , Exocortex ,Intelligence amplification ,Isolated brain ,Neuroprosthetics Neurotechnology , Optogenetics ,Sensory substitution ,Synthetic telepathy.

3.4 TESTING AND TRAINING OF BRAIN PORT:

This device has been tested on several blind people; one among them is Erik Weihenmayer. A genetic eye condition known as retinoschisis caused him to be visually impaired at birth and completely blind by age 13. In retinoschisis, tiny cysts form within the eye's delicate retinal tissue, eventually causing its layers to split apart. Neither medication nor surgery can restore sight. But with the help and practicing this device he was at least able to identify the obstacles, objects around him and can also read the signs. And by use of this device he has climbed mountains around the world—the highest peaks, in fact, on every continent.

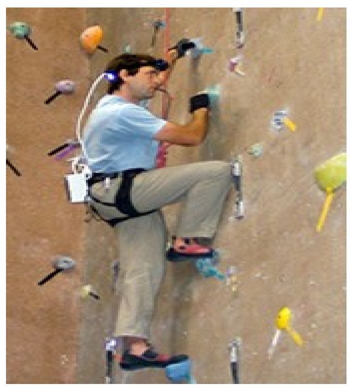


Fig.3.9 blind person climbing wall

The images below demonstrate how information from the video camera is represented on the tongue. Today's prototypes have 400 to 600 points of information on a ~3cm x 3cm tongue display, presented at approximately 30 frames per second, yielding an information rich image stream. Our research suggests that the tongue is capable of resolving much higher resolution information and we are currently working to develop the optimal tongue display hardware and software.

Fig.3.10 shows static and dynamic images interpreted by blind people using device

Sonly had between 100- and 1032-point arrays, the low resolution has been sufficient to perform complex perception and "eye"-hand coordination tasks. These have included facial recognition, accurate judgment of speed and direction of a rolling ball with over 95% accuracy in batting a ball as it rolls over a table edge, and complex inspection-assembly tasks. The latter were performed on an electronics company assembly line with a 100-point vibrotactile array clipped to the work-bench against which the blind worker pressed the skin of his abdomen, and through which information from a TV camera substituting for the ocular piece of a dissection microscope was delivered to the human-machine interface (HMI)

How long does it take to learn?

Our current research studies involve participation between 2-10 hours*. Within minutes of introduction, users may understand where in space stimulation arises (up, down, left and right) and the direction of movement. Within an hour of practice, users can generally identify and reach for nearby objects, and point to and estimate the distance of objects out of reach. With additional training, subjects can identify letters and numbers and can recognize landmark information when using the device in a mobile scenario.

After a few hours of training, some users have described the experience as resembling a low-resolution version of the vision they once had. In addition, neuroimaging research suggests that for blind individuals, visual regions of the brain are activated while using the Brain Port vision device. Ultimately, the experience is uniquely individual. However, the resulting perception does not need to "feel" like eye-based vision in order to provide assistive benefit.

You can adjust the intensity of the stimulation to your comfort level. Participants have reported that the impulses feel like champagne bubbles effervescing on their tongue.

Fig 3.11 Blind can see with the help of Brain port

Treatment:

Subjects received clinic training for 3-5 consecutive days (2 one-hour sessions each day) with the Brain Port balance device. Each training session included up to 9 short (1-5 minute) training sessions, followed by a 20 minute training session, in progressively challenging positions. Subjects continued training at home for two 20- minute sessions each day for the duration of the study.

3.5 APPLICATIONS OF BRAIN PORT DEVICE

1. One of the applications which has been commercialized is providing vestibular or balance information for people with balance disorders. This is a simple form of sensory substitution, in which the tongue is used to present information from an artificial balance sensor.

2. Another application is providing directional or navigational information for people who operate under central command and control scenarios, such as military and civilian rescue personnel. Providing information via the tongue allows them to fully use their vision and hearing to respond to unforeseen threats or hazards. We have shown in the laboratory that it is possible

to navigate a virtual maze (like a simple video game) using only information received on the tongue (i.e., buzz on right side of tongue means turn right, etc.).

3. A third, more ambitious application would be providing very crude visual information through the tongue for persons who are completely blind. Our colleague Eliana Sampaio at the Louis Pasteur University in Strasbourg, France has used our tongue stimulator with a small video camera and demonstrated an equivalent visual acuity of about 20-to-830, which is very poor vision, but possibly useful for certain limited activities with enough practice. Wicab, Inc continues to improve this technology with the aim of commercializing it.

4. A fourth application would be providing tactile feedback to the human operators of robots used for various tasks. For example, UW professor Nicola Ferrier is developing a robot controlled by the tongue of persons with quadriplegia which could incorporate touch sensors into its gripper, relaying the touch information back to the user's tongue.

- Providing elements of sight for the visually impaired
- Providing sensory motors training for stroke patients
- Providing tactile information to brain when a part of the body has nerve damage
- Used at the time of wars
- Enhancing the integration and interpretation of sensory information in autistic people

- Just a few of the current or foreseeable applications include providing elements of sight for the visually impaired in the medical field.
- The BrainPort electrodes would receive input from a sonar device to provide not only directional cues but also a visual sense of obstacles and terrain.
- Brain Port may also provide expanded information for military pilots, such as a pulse on the tongue to indicate approaching aircraft or to indicate that they must take immediate action.
- Brain Port applications include robotic surgery. The surgeon could wear electrotactile gloves to receive tactile input from robotic probes inside someone's chest cavity.

3.6 CURRENT AND POTENTIAL APPLICATIONS

- While the full spectrum of BrainPort Vision Technology applications has yet to realized, the device has the potential to lessen an array of sensory limitations and to alleviate the symptoms of a variety of disorders.
- Just a few of the current or foreseeable applications include providing elements of sight for the visually impaired in the medical field.
- Beyond medical applications, scientists have been exploring potential military uses with a grant from the Defense Advanced Research Projects Agency (DARPA). They are looking into underwater applications that could provide the Navy Seals with navigation information and orientation signals in dark, murky water.
- The BrainPort electrodes would receive input from a sonar device to provide not only directional cues but also a visual sense of obstacles and terrain.
- BrainPort may also provide expanded information for military pilots, such as a pulse on the tongue to indicate approaching aircraft or to indicate that they must take immediate action.
- Other potential BrainPort applications include robotic surgery. The surgeon could wear electrotactile gloves to receive tactile input from robotic probes inside someone's chest cavity. In this way, the surgeon could feel what he's doing as he controls the robotic equipment.
- Race car drivers might use a version of BrainPort to train brains for faster reaction times, and gamers might use electrotactile feedback gloves or their controllers to feel what they're doing in a video game.

3.7 ADVANTAGES

Blind users can use the BrainPort vision device independently - at home, at work, and in public spaces indoors and out as a tool for improved safety, mobility and object recognition.

Secondary benefits include applying the technology toward specific hobbies and recreational situations. These benefits enable greater independence at home, school and in business, greatly improving quality of life.

SAFETY

- Navigating difficult environments, such as parking lots, traffic circles, complex intersections
- Recognizing quiet moving objects like hybrid cars or bicycle

MOBILITY

- Finding doorways, hall intersections, lobby or restaurant in an office or hotel.
- Finding continuous sidewalks, sidewalk intersections and curbs.

OBJECT RECREATION

- Locating people
- Locating known objects such as shoes, cane, coffee mug, keys
- Brain Port device does not replace the sense of sight, it adds to other sensory experiences to give users information about the size, shape and location of objects.
- Users can operate it independently with a hand-held controller.
- A pair of sunglasses wired to an electric "lollipop" helps the visually impaired regain optical sensations via a different pathway Therefore device is like normal sunglasses hence it does not look bad.
- It uses a rechargeable battery like in normal cell phone

4. FUTURE ENHANCEMENT

- This technology can't be adapted to work on senses the brain doesn't already have. So, the research center wibac is trying to implement this kind of people also.
- The Brain Port requires training the brain incrementally using daily practice sessions. Reduce time period of learning classes
- When it comes in market its cost is around $10,000 so it cannot be afforded by common people, and it will reduced in future.
- Occasionally it will produce weak metallic taste sensations, a minor side effect. We have never observed any kind of tissue irritation with the gold-plated electrodes**.**

5. CONCLUSION

Science has always provided mankind with answers and solutions, and science will continue to do so, while simultaneously supplying us with improvements upon previous technologies or new technologies altogether. Today, humanity owes the majority of our commodities, from prosthetic limbs to iPods, to years of scientific research and collaboration between different scientific disciplines. Unfortunately, however much science may have contributed to improving our lives, there is still plenty of headway to be made. We are always looking for areas in which our interdisciplinary strengths can be leveraged to revolutionize areas of science, engineering and technology, and to improve quality of life for millions of people.”

To substitute one sensory input channel for another, you need to correctly encode the nerve signals for the sensory event and send them to the brain through the alternate channel. The brain appears to be flexible when it comes to interpreting sensory input. You can train it to read input from, say, the tactile channel, as visual or balance information, and to act on it accordingly. ”It’s a great mystery as to how that process takes place, but the brain can do it if you give it the right information.”

There is a hope that a balance device that uses nerve fibers on the tongue to transmit information about head and body position to the brain can make a serious difference for patients whose sight cannot be replaced. Thus we hope that blind people can also see this colorful world by using this brain port device.

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