Loser: Tongue Vision

By: **Sandra Upson**

LOSER
BIOMEDICAL

ILLUSTRATION: JASON LEE

Imagine being blindfolded and having an array of electrodes sitting on your tongue. Around your neck hangs a flat box containing a microprocessor, and your lips close around a long cord that connects to the box and a camera. The cord dangles halfway down your chest, as if you're drooling electronics. While you tentatively direct the camera, you feel your tongue vibrate at tiny discrete points that form a circle. The electronics in your mouth are telling you that you are facing a round object. It might be a tennis ball right in front of you. But then again, it might be a hot-air balloon a kilometer away. You really can't tell.

The main idea of the BrainPort is to help blind people by translating visual information into tactile cues. A video feed is reduced to simple shapes, which are then drawn on the tongue by activating certain electrodes, each of which applies a small voltage that lightly tingles the tissue. As you turn the camera to explore an area, the electrodes respond with different patterns of mild zaps to indicate the shapes of objects in the camera's field of view. The sensory experience of the BrainPort, in visual terms, is a flat world rendered in blurry, monochromatic silhouettes.

Critics say most blind people would find information at such a low level of detail, transmitted through the tongue, to be of limited value in decoding the clutter and chaos of everyday life. Given its estimated US $5000 price tag, doubts about the BrainPort's utility are compounded by questions of whether low-vision consumers will prefer it to other, cheaper assistive technologies.

Developed and marketed by Wicab, a small company in Middleton, Wis., the BrainPort is an offshoot of vision-loss research done by Paul Bach-y-Rita and colleagues in neighboring Madison at the University of Wisconsin's biomedical engineering department. The device's cord is an awkward, potentially embarrassing feature that was summarily rejected by everyone contacted for this article. Even Wicab's chief executive, Robert Beckman, says, "To be commercially feasible, we need to be in a wireless format, where the array is mounted on a tray that is fixed on your upper teeth."

"We've made an array that mounts that way," he adds. But the wireless aspect is still to come.

Although those changes would definitely improve the device's cosmetic appeal, the inherent shortcomings of the sense of touch impose a low ceiling on the ambitions of any tactile vision device. Not only is the BrainPort limited by the size of its array, which consists of 100 electrodes in a 10-by-10 grid, it is also hampered by the simple fact that the human brain has not evolved to process large amounts of tactile information simultaneously.

What the Experts Say *GORDON BELL: It's just a research project trying to get PR.*

Even if the tongue and the array were able to provide the canvas for a detailed, pointillist masterpiece and a palette of strong and weak buzzes were calibrated to mimic gray scale, the result would present a serious cognitive challenge. The patterns would dissolve into nonsense, the signal lost in an onslaught of zaps. "It's too hard to learn to integrate all this information—it's not natural," says Hong Tan, an electrical engineering professor at Purdue University, in West Lafayette, Ind., who works on tactile human-machine interfaces.

A camera–tongue display combination would not be able to convey enough detail to let a sightless person get around safely, so a user would still need to rely on a Seeing Eye dog or a cane to contend with such obstacles as a drop-off at a stairway or a curb, or a glass door. "I think it's easy to recognize fairly simple, high-contrast objects on a black or a white background—that can be done," says Richard Normann, a bioengineering professor working on the University of Utah's visual neuroprosthesis project. "But our world is not that kind of visual world."

The fact that the system can only supplement other aids raises a logistical issue: the camera would have to be attached discreetly to the user's head, so that his or her hands are free to, for example, hold a cane or a dog's harness.

BrainPort

GOAL: To help people with serious vision loss navigate by translating visual data from a camera into vibrations on the tongue; also to assist people with balance disorders by providing tactile feedback on changes in the way the head tilts.

WHY IT'S A LOSER: The technology seems unlikely to provide enough clear benefits to counterbalance the cost and annoyance of wearing the device.

PLAYER: Wicab.

WHERE: Middleton, Wis.

STAFF: 6 engineers.

BUDGET: US $6 million to $6.5 million for vision, funded through National Institutes of Health and DARPA grants.

MORE: http://www.wicab.us

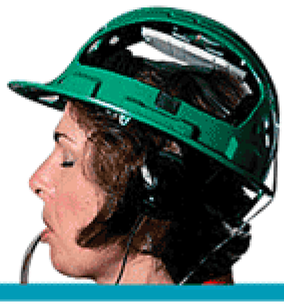

PHOTO: WICAB

The concept of translating the visual world into sensory stimulation is not at all outlandish. Many vision researchers are investigating ways to safely implant electrode arrays, either in the visual cortex or at some other point along the pathway from the retina to the cortex. The tongue, also, is not such an absurd location. Unlike the skin, it has a relatively constant amount of moisture on the surface, making the electrical signal less likely to fluctuate there than elsewhere on the body, where sweat and other moisture can change the skin's conductivity. The tongue also has better resolution than most areas of skin, allowing the points on the electrode array to be clustered closely together.

Bach-y-Rita began researching the technique of sensory substitution in the 1960s. The idea is that over time the mind grows accustomed to the buzzes and stops attending to them consciously, perceiving them only in visual terms. His first major effort at replacing vision was a tactile vision substitution system (TVSS), which consisted of a camera and a panel of buzzing electrodes mounted on the back of a chair. The camera would scan an area and display the images as vibrations the user would feel on her back. “TVSS failed because it could only do the outline well—it lacked internal detail,” Tan says. “I suspect the BrainPort will suffer the same problem: the edge gets enhanced, but everything else is suppressed.”

Compare the BrainPort to a similar device, the Optacon, a relatively popular tool in the 1970s and 1980s. A blind person would hold part of the Optacon under a finger to scan ordinary text, and pins in the device would vibrate in the shapes of letters. Initially, the device received excellent reviews, but it ultimately failed, because many users felt it was slow and had a difficult learning curve.

Another major factor is cost. Michael Wigle, an access technology specialist at the Cincinnati Association for the Blind and Visually Impaired, has found that Global Positioning System devices intended for the blind have struggled simply because they are too expensive, even though they can increase a person’s mobility by reciting directions and the names of nearby businesses. “You add a $1500 GPS device and they don’t have to ask someone what intersection this is,” Wigle says. “But you run into a lot of people asking themselves, ‘Am I willing to fork over that much money, or can I just swallow my pride?’ ”

What the Experts Say *NICK TREDENNICK: This one is hopeless; $5000 to $6000 is way out of range for most blind people. Few are rich.*

Even so, GPS has the advantage that it is a common technology needing only adaptive tweaks to assist the sightless. Advocates for the blind say prospective users generally favor devices that help them blend in with mainstream society, while tending to shun anything that seems to be leading them into a cyborg realm.

Wigle adds that any technology costing more than $1000 will succeed only if its benefits are enormous and obvious. Many people with low or no vision already invest in assistive technologies such as PDAs that offer Braille-based e-mail, word processing, and music players. At some point, though, people will have to choose among the available options, he says. The BrainPort or the PDA? The BrainPort or the GPS? And those choices dilute the number of users who will be interested in the BrainPort system, especially for the $5000 to $6000 that Wicab expects to charge per device.

The BrainPort is being developed for other applications, including low-light navigation for the military, and Wicab has also begun selling BrainPort devices in Europe and Canada to people with an impaired sense of balance.

In this application, the tongue array is attached to an accelerometer. The electrodes transmit buzzes corresponding to changes in the head’s tilt, to warn the user of an impending fall. Similar devices also address balance disorders by providing feedback to the brain, such as one that uses auditory cues and a waist belt that buzzes to reflect changes in tilt. It isn’t clear yet whether the BrainPort will emerge as the most elegant solution to balance disorders.

Meanwhile, Wicab claims the vision application is still a few years away. Most people contacted for this article said they could imagine some people happily using the device if Wicab does away with the cord. But the history, the logistical realities, and, not least, the many uncertainties that lie along the way make it a long shot.