Can you see what I hear? Blind human echolocators use visual areas of the brain

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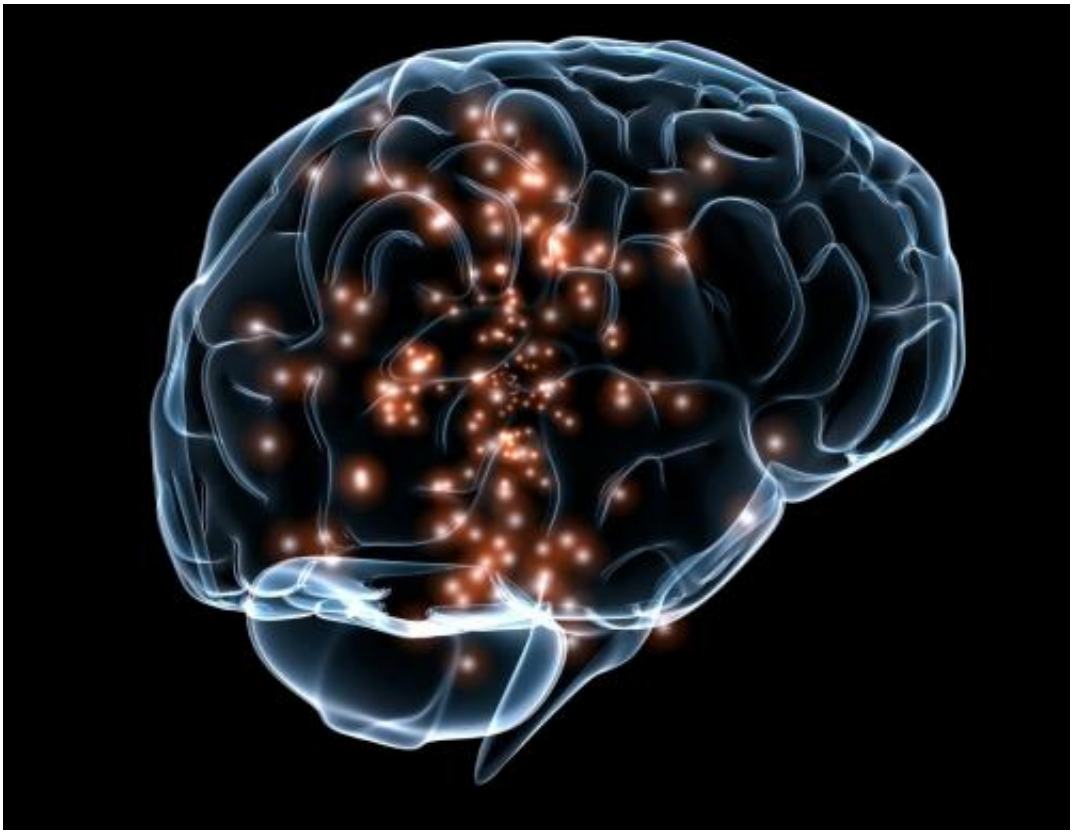

Credit: Wikimedia Commons

Certain blind individuals have the ability to use echoes from tongue or finger clicks to recognize objects in the distance, and some use echolocation as a replacement for vision. Research done by Dr. Mel Goodale, from the University of Western Ontario, in Canada, and

colleagues around the world, is showing that echolocation in blind individuals is a full form of sensory substitution, and that blind echolocation experts recruit regions of the brain normally associated with visual perception when making echo-based assessments of objects. Dr. Goodale's latest results were presented at the 9th Annual Canadian Neuroscience Meeting, on May 24th 2015 in Vancouver British Columbia.

"Our experiments show that echolocation is not just a tool to help visually-impaired individuals navigate their environment, but can act as an effective sensory replacement for vision, allowing them to recognize the shape, size, and material properties of objects" says Mel Goodale.

Just like multiple properties (size, expected weight, texture, composition) of an object assessed by visual cues are encoded in different brain regions, recent research done in the Goodale laboratory shows that the same is true of information obtained through the auditory cues provided by echolocation. Indeed, many of the same regions in the sighted brain that are used for the visual assessment of objects are recruited in the blind brain when objects are explored using echolocation.

To understand what an object is, and to know how to interact with this object, knowing what an object is made of, its "stuff", is equally important as knowing its structure or shape. While his initial studies have investigated how echolocators detect the shape and distance of objects, Dr. Goodale's most recent studies have investigated how they perceive the material or "stuff" that different objects are made of.

"Remarkably, expert blind echolocators can tell whether something is hard or soft, dense or not, just by listening to the echoes bouncing back from that material" notes Dr. Goodale.

While sighted individuals use visual cues to get information about the composition of objects, such as the sheen of metal, or the fuzziness of fur, echolocators must rely on the auditory cues that result from the echoes of the clicks they emit. To determine how the brains of echolocators process these cues, researchers have recorded the echoes produced by echolocator's clicks on different materials (a blanket, fake foliage and a whiteboard) and looked at the response these sounds produced in the brains of sighted people, of blind non-echolocators and of blind echolocators. To view which brain regions were activated in these individuals, an advanced brain imaging technique called functional magnetic resonance imaging (fMRI) was used.

These studies show that material-related signals activate a region of the brain called the parahippocampal cortex (PHC) in blind expert echolocators, but not in sighted people or blind non-echolocators. PHC activation is associated with scene perception in sighted individuals. Just as in sighted individuals using vision, the brain regions that play a critical role in processing the structure and geometry of objects are distinct from the brain regions that process the cues that signal the material properties of objects in blind echolocators.

Interestingly, other studies in the Goodale lab have shown that blind expert echolocators are also subject to illusions, for example the size-weight illusion in which the perception of mass is influenced by the size of an object. If two objects of equal weight are presented to both a sighted and a blind echolocator, both will find the smaller object feels heavier when they lift it using a string attached to a pulley. This illusion, thought to be based on the lifter's cognitive expectations, and the fact that it is also present in blind echolocators, but not in blind non-echolocators, shows that echolocation is an effective form of sensory substitution for vision.

Because echolocation allows blind individuals to perceive objects from a

distance, it can be used as an alternative to vision, allowing the perception of distant objects that would be impossible through touch. In fact, some echolocators are proficient enough to use this ability to perform complex tasks such as riding a bicycle - or even sinking a basketball!

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