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Sensory systems: Do you hear what I see?

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Abstract

Researchers have found evidence that the representation of auditory and tactile information in the brains of blind people shows strong similarities to the way in which visual information is represented in sighted people.

Almost one-quarter of the brain is normally devoted to processing visual information: reading text, recognizing faces, following the Sunday match, and much more. The brain's visual cortex contains specialized regions devoted to processing motion, text, faces, scenes, objects and even the position and movement of bodies. In congenitally blind individuals, much of the 'visual' cortex responds strongly to auditory and tactile input rather than to visual stimuli, a phenomenon known as cross-modal plasticity. Writing in *Current Biology*, Striem-Amit and Amedi¹ shed light on how these cross-modal responses are organized.

The researchers trained congenitally blind individuals for 70 hours in the use of a technology² that converts visual information into 'soundscapes' (called vOICE). After an initial click, an image frame is scanned from left to right and then represented by a sequence of 'chords'. Brightness is represented by loudness, height in the scene is represented by pitch and horizontal position is represented by the time since the click. For example, a diagonal line stretching upward from left to right becomes the sound of an ascending sweep.

The authors used functional magnetic resonance imaging to measure the brain responses of participants while they listened to soundscapes of body-shape silhouettes, objects, faces and abstract patterns. These brain responses were compared with those of sighted individuals viewing the corresponding visual images. Both blind and sighted subjects showed larger responses to body-shape silhouettes than to other images within a region of the brain known as the extrastriate body area (EBA), which, in individuals with normal sight, is involved in visual perception of the human body.

One of the most interesting conclusions that Striem-Amit and Amedi draw from their results is that the specialization for body-shape information in the EBA is innate, requiring little experience to develop, because selectivity for body-shape silhouettes in this brain area occurs even in blind individuals with little or no experience of body shape before training with vOICE. Thus, the authors interpret their findings as evidence that the specialization found in the visual cortex may exist independently of experience.

This claim is based on the assumption that congenitally blind individuals have a deeply impoverished experience of others' body postures, actions and movements. Indeed, the authors claim that this information is available to blind individuals solely through touch, and

that they have no auditory experience of body shape before vOICe training. However, in the course of our research, my laboratory has noticed that many visually impaired individuals report knowing a surprising amount about body positions, actions and intents from sound alone. Visually impaired subject Mike May reports: “I know when people are getting bored by my presentation because I can hear them shuffling in their chairs.” A fully blind colleague, Nick Giuduce, admits: “When I’m interested in a woman, I can tell if she’s slender by how much the floor creaks as she walks by.” Amy Burk, the Canadian goalball player shown on the right in Figure 1, reports: “I can see it all ... I can visualize it all ... if they are moving with the ball I’m moving with them ... whatever side they are going on I’m following the person.” It is reasonable to suggest that the EBA has a role in interpreting these auditory experiences in blind individuals.

Regardless of whether auditory experience before training with vOICe involves the EBA, this study adds to a body of work suggesting that ‘functional constancy’ is one of the organizational principles underlying cross-modal plasticity in blind people³. According to this principle, specialized brain regions continue to serve the same function in blind individuals, but there is a shift in the regions’ primary sensory input from sight to hearing or touch. A variety of studies have provided evidence for functional constancy in blind individuals. These showed that the visual-motion area of the brain responds to auditory and tactile motion^{4, 5, 6}, that sounds made by objects are represented in brain regions associated with visual-object recognition^{7, 8}, and that reading Braille elicits brain responses in the visual word-form area⁹.

There is an appealing elegance to the idea that the representation of auditory and tactile information in the ‘visual’ cortex of blind individuals is analogous to that of sighted people. But the extent of the apparent similarity may be partly a consequence of hypotheses being tested from a sighted perspective. Experiments published so far have relied on measuring brain responses to auditory stimuli that have been experimentally selected and categorized on the basis of what makes intuitive sense to us as sighted scientists. This may result in an overemphasis of apparent similarities.

More-detailed examination of the response profiles of seemingly analogous areas of the brain using a wider variety of stimuli may yet reveal important differences between blind and sighted individuals, both in the way that information is represented and in the function of these areas with respect to perception and behaviour. Indeed, in their discussion, Striem-Amit and Amedi note that the representation of bodies is not identical in blind and sighted individuals. A second region of the brain that seems to represent body shape, the fusiform body area (which may contain a more holistic representation of body position), showed reduced selectivity to body-shape information in the blind individuals they studied. Moreover, the intriguing possibility that blind people have specialized regions that contain representations of the world with no sighted equivalent remains almost entirely unexplored.

References

1. Striem-Amit E, Amedi A. *Curr Biol*. 2014; 24:687–692. [PubMed: 24613309]
2. Meijer PBL. *IEEE Trans Biomed Eng*. 1992; 39:112–121. [PubMed: 1612614]

3. Pascual-Leone, A.; Hamilton, R. Progress in Brain Research. Casanova, C.; Ptito, M., editors. Vol. 134, Ch. 27. Elsevier; 2001. p. 427-445.
4. Poirier C, et al. NeuroImage. 2006; 31:279–285. [PubMed: 16443376]
5. Saenz M, Lewis LB, Huth AG, Fine I, Koch C. J Neurosci. 2008; 28:5141–5148. [PubMed: 18480270]
6. Bedny M, Konkle T, Pelphrey K, Saxe R, Pascual-Leone A. Curr Biol. 2010; 20:1900–1906. [PubMed: 20970337]
7. Mahon BZ, Anzellotti S, Schwarzbach J, Zampini M, Caramazza A. Neuron. 2009; 63:397–405. [PubMed: 19679078]
8. Amedi A, et al. Nature Neurosci. 2007; 10:687–689. [PubMed: 17515898]
9. Striem-Amit E, Cohen L, Dehaene S, Amedi A. Neuron. 2012; 76:640–652. [PubMed: 23141074]

Figure 1.

Using sound instead of sight. In goalball, a sport designed for blind athletes, players use sound to determine the position of both the ball and the other players. Striem-Amit and Amedi¹ report that auditory stimuli are processed in blind people by a region of the brain that is associated with vision in sighted individuals. (Clive Rose/Getty)