This is an excerpt from a report on the Sensory Substitution and Augmentation Conference at the British Academy in March of 2013, written by Kevin Connolly, Diana Acosta Navas, Umut Baysan, Janiv Paulsberg, and David Suarez, available at http://networksensoryresearch.utoronto.ca/Events_%26_Discussion.html

2. What can sensory substitution tell us about perceptual learning?

Eleanor Gibson defines perceptual learning as "any relatively permanent and consistent change in the perception of a stimulus array, following practice or experience with this array" (1963, p. 29). Are cases of sensory substitution cases of perceptual learning? The answer to this question depends on whether the incorporation of a sensory substitution device yields a perceptual change, rather than a strictly cognitive change. Suppose we assume a perceptual change—one that is permanent, consistent, and results from practice. What would sensory substitution tell us, then, about perceptual learning?

Fiona Macpherson suggested one way in which we might go about answering this question. We might proceed by comparing and contrasting the learning that goes on in sensory substitution devices with other kinds of perceptual learning. For instance, we might compare sensory substitution learning with the learning that occurs when a blind person with cataracts has an operation to get them removed. Several people took up this comparison throughout the conference.

Citing Pawan Sinha's work, Amir Amedi argued that the blind can develop crossmodal matching very quickly (although they do not have it immediately upon having their cataracts removed), and that the same is true with the vOICe.[1] On the other hand, he continued, even several months after surgery, Sinha's subjects fail at visual parsing—the ability to tell whether something is one or more objects. In contrast, in just seventy hours of training with the vOICe,

[1] As Kiverstein, Farina, and Clark describe it, "The vOICe is a visual-auditory substitution device that works by transforming images from a digital camera embedded in a pair of sunglasses into auditory frequencies ("soundscapes"), which the user hears through headphones" (forthcoming).

subjects are able to do visual parsing. Mohan Matthen later added another point of disanalogy between sensory substitution cases and cataract removal cases. In cataract removal cases, there is no problem with locating the stimulus. In contrast, with sensory substitution devices, there is the additional step of distal localization, that is, locating the distal stimulus based on the proximal stimulus that one experiences. As Malika Auvray and Ophelia Deroy have shown, distal localization requires training. So unlike in the cataract removal cases, with sensory substitution devices, localization is not automatic.

The comparison between sensory substitution cases and cataracts removal cases is just one way in which we can find out about perceptual learning. Macpherson suggested three additional ways. First, we might compare and contrast different sensory substitution devices, as well as thinking about what happens when you use them in tandem. The former is important because some sensory substitution devices offer unique instances of perceptual learning. For example, Peter Konig argued that the Feelspace belt enlarges egocentric space about ten fold, allowing subjects to interact with objects well beyond their visual range. Other sensory substitution devices do not do this. Second, we might compare and contrast sensory substitution devices with inverting lenses. For instance, how is substituting a modality different from inverting the information in an existing one? Third, we might think about very basic sensory substitution systems, and ask if the kind of learning that goes on in those cases is the same as the kind of learning that goes on in more complex sensory substitution cases. For instance, in his commentary on Amir Amedi's talk, Derek Brown spoke of Pavlov's bells as being a very basic form of sensory substitution. We might also think about braille and sign language as kinds of sensory substitution devices. Again, we can ask in each of these cases whether ask if the kind of learning that goes on in it is the same as the kind of learning that goes on in sensory substitution.

What then can comparing and contrasting the learning that goes on in sensory substitution devices with other kinds of perceptual learning teach us about perceptual learning? Perhaps the best way to answer this is not by trying to come up with a single, unified thing that such devices teach us. Rather, we might treat each device on its own as an instance of perceptual learning, with perhaps something unique to teach us about what is possible in perceptual learning. We can then be sensitive to differences in kinds of sensory substitution devices, the different training regimes involved, and the different subjects who are using them (whether they be early blind or late blind, for instance). This allows us to abide by Fiona Macpherson's advice that when thinking about sensory substitution devices, we should pay close attention to the fine-grained details of the cases.

References:

Gibson, E. J. (1963) "Perceptual learning." *Annu. Rev. Psychol.* 14, 29–56.

Kiverstein, J., Farina, M., and Clark, A. (forthcoming). "Substituting the Senses." In Mohan Matthen (ed.), *The Oxford Handbook of the Philosophy of Perception*. Oxford University Press.