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

5. What are the limitations of sensory substitution?

Many speakers and commentators in the conference mentioned the limitations of sensory substitution, emphasizing in particular that sensory substitution is not the *substitution* of an entire sensory modality, but rather the replication of several features of that modality. Since sensory modalities carry information about a range of properties, an important feature that sensory substitution attempts to replicate is the feature of *conveying information*. But questions arise: About what sorts of properties can and *cannot* sensory substitution convey information? If information about some properties cannot be conveyed by sensory substitution, then does this mean that sensory substitution has serious limitations? Can the information that is conveyed be rich enough to replicate other features of sensory modalities?

As several speakers at the conference pointed out (most notably Charles Spence), the focus of the sensory substitution research has been vision. Vision allows us to gather rich information about our environments. Since the early days of sensory substitution research, sensory substitution devices have been able to convey a fair amount of information about environment. Subjects using sensory substitution devices are reported to recognize objects, point to objects accurately, judge the distances and the sizes of objects, and even make complex pattern discriminations. Based on these, it might be suggested that sensory substitution devices can carry information about, at least, the *common sensible:* namely, motion, shape and size properties of the objects in the environment. However, there seems to be some limitations even in such cases. As Laurent Renier discussed, some sorts of experiences that are related to depth and distance perception cannot be generated with sensory substitution devices in congenitally

blind subjects. If these show that depth perception can only be replicated in late-blind and sighted subjects, then there is a problem that sensory substitution researchers should resolve.

Even if information about common sensibles were to be properly conveyed by these devices, there would still be a limitation with respect to the substitution of the experience of *proper sensibles* such as the color, smell and taste properties of objects. Whether this limitation results from the impossibility of replicating the properly perceptual aspects of proper sensibles, or from technical or design-related problems is a question that remains to be settled. Here, a lot hinges on what theories about perceptual experience are true. If one believes, as Jonathan Cohen argued in his talk, that there are good reasons to think that some features of visual experience are emergent, and so do not supervene on the information that is conveyed by sensory substitution devices, then one might think that sensory substitution cannot restore those emergent features simply by delivering the right information. Moreover, this or a similar reason might also explain why there are no well-known examples of the substitution of senses like taste and smell. If this point generalizes across many of the proper sensibles, then it seems that sensory substitution faces a serious limitation.

Even if we assume that it is possible to convey very rich information to subjects by sensory substitution devices, we might still ask whether sensory substitution has other limitations. Malika Auvray and Ophelia Deroy mentioned that sensory substitution research has not yet been able to generate a typical profile of emotional and hedonic responses. Additionally, as Jerome Dokic noted, there are some reasons to think that non-sensory perceptual feelings of familiarity and presence do not supervene on the conveyed sensory content, suggesting that such feelings may not be reliably generated by sensory substitution. As Renier pointed out, however, the absence of hedonic aspects might be due to the very basic nature of the stimuli used (lines,

shapes, simple patterns etc.). Although such perceptual feelings do not supervene on the sensory content, Dokic suggested that they might be the result of a post-perceptual process which can be transferred to sensory substitution subjects. If these considerations are correct, then some limitations might only be technical ones that can be overcome in principle.

A very important feature of sensory experience is its *phenomenology*, and there seems to be a significant limitation with respect to the generation of perceptual phenomenology through sensory substitution. Several people pointed out that even if sensory substitution devices can convey a rich array of information, the *feel* of seeing something might not be transferred to other modalities. As pointed out by Macpherson, however, such worries may be motivated by an anti-representationalist assumption according to which the content of perception leaves out phenomenology. If so, then sensory substitution's limitations with respect to generating phenomenology will depend on which theories of perceptual experience are true.