Engineering conceptual change: The Enactive Torch

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Summary: In the Philosophy and Engineering community, there is general agreement that interaction between the two fields can be mutually beneficial. However, there are distinctive ways in which engineering can play a crucial role in assisting the particular case of philosophy of mind, especially concerning our understanding of conscious experience and perception. The reciprocal design/use cycle of certain kinds of experience-augmenting technologies can facilitate the kind of conceptual advance that is necessary for progress toward a scientific account of consciousness, a kind of advance that is not possible to induce, it is argued, through traditional discursive, rhetorical and argumentative means. We present an example of engineering activity that plays this crucial role in informing philosophical research in the PAICS group at the University of Sussex: the design and use of a novel sensory substitution device (the Enactive Torch) as a means of inducing in the user new philosophical concepts of perceptual experience.

1. The need for activity-based conceptual change

Many of our problems in trying to understand consciousness are conceptual; the obstacles we face in understanding what it is for a physical thing to also be an experiencing thing are not just a matter of lacking empirical data. Even if we knew much more about the nervous system than we do now, some fundamental puzzling questions would remain. For example, on our current concept of consciousness, zombies seem possible. That is, it seems possible that there could be something that is physically (and thus behaviourally) identical to you and yet different from you with respect to its experiential properties, even to the point of not having any experiences at all: a zombie-you. Such a possibility poses serious difficulties for a naturalistic, scientific account of consciousness (cf, e.g., Chalmers 1996).

One way of responding to this is to diagnose the difficulty as the result of flaws in our concept of consciousness. If our concept of consciousness has near-paradoxical implications, perhaps we should try to develop a new concept of consciousness that does not (cf, e.g., Nagel 1980). But it seems unlikely that the kind of conceptual change required can itself come about solely through conceptual processes alone, such as adding propositions to, or subtracting propositions from, one's stock of beliefs (whether it be by learning some more facts about consciousness or about the brain, or by engaging in philosophical arguments), or creating a new concept out of logical combinations of the concepts one already possesses. Rather, such changes might require the philosopher concerned to undergo certain kinds of experience, those that result from engaging in certain forms of activity. If being able to shift from seeing an object one way to seeing it another way is the "mastery of a technique" (Wittgenstein 1972, p 208), or a skill, then perhaps, too, being able to shift from understanding consciousness in our current inchoate way to another way that is less paradoxical and problematic, can itself be seen as requiring the possession of a skill. And skills, notoriously, cannot be transmitted merely linguistically or through argumentation; typically, they require engaging in a particular form of activity. Perhaps, then, the kinds of conceptual advance we require for better philosophical concepts of consciousness require the philosopher to experience active engagement with consciousness-related phenomena in some way. This position is called "interactive empiricism" (Chrisley 2008a, Chrisley 2008b).

Another way of making the point is this. A general science of human cognition should apply to individual cognizers; specifically, it should apply to cognitive scientists, philosophers, and engineers. If cognitive science is telling us that cognition in general, and conceptual development in particular, is crucially interactive, then it may also be that making philosophical advances via conceptual development will necessarily involve engaged, experiential activity.

2. An engineering solution: The Enactive Torch

The Enactive Torch (see figure 1) was designed by Froese and Spiers (2007) as a tool to aid the philosophical and scientific investigation of perception. It was inspired by the observation that while there is much debate concerning, e.g., the phenomenology of using sensory substitution devices, so far no agreement could be reached on how best to characterize that phenomenology, and that this was likely due to the fact that the philosophers participating in the debate had apparently never tried out these devices for themselves. Thus, of special concern for the design of the Enactive Torch was the notion that the device should be very accessible for first-person use. More precisely, this meant that it had to be cheap, non-intrusive and easy to build such that it has the potential of becoming widely distributed to the research community, as well as being simple enough to use such that it did not require hours of training but still generated interesting insights. The Enactive Torch fulfils these requirements as a simple distal-to-tactile sensory substitution device that translates the distance measures of one ultrasonic sensor to a single tactile (rotary or vibratory) output to the hand. Below we elaborate more fully on why the device was engineered in this manner.

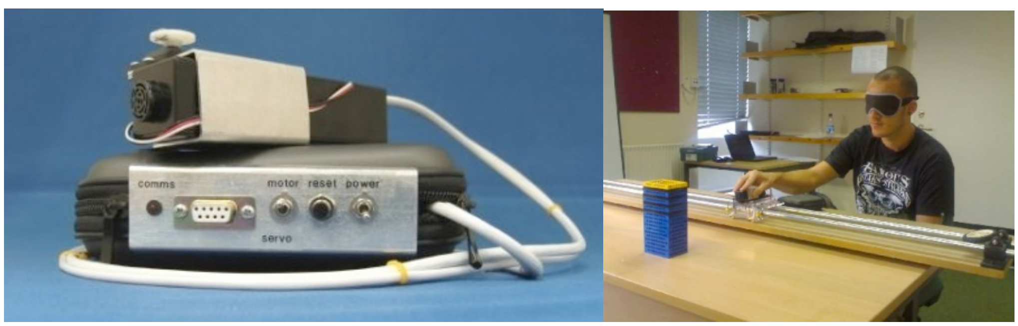

Figure 1. Left: The Enactive Torch Mark 2 (ET2). Right: Constrained movement experiment using ET2. Images from http://enactivetorch.wordpress.com/

2.1. Depth information

Since color perception is one of the key properties of the visual modality, it is not surprising that most visual-to-tactile sensory substitution systems are designed to translate color information of the environment (i.e. in the form of a black and white or gray scale image) to tactile stimulation of the body (i.e. an array of vibrators on the stomach or tongue). However, completely reducing vision to the perception of colour leads to an impoverished characterization of the function and phenomenology of the visual modality. The perception of depth (and space in general) is arguably just as important. Indeed, in terms of an evolutionary perspective it could be said that it is more essential to perceive how far away a predator is compared to one's current location rather than whether it happens to be blue or white. The importance of depth perception through the visual modality for our everyday lives is exemplified by the fact that the blind can do well without perceiving colour but generally do have to rely on a cane (which provides a sense of distance to surrounding objects) to find their way around the environment.

2.2. Tactile output

It has been argued by Auvray and Myin (submitted) that sensory substitution devices using tactile output are faced with certain limitations (i) because they depend on the stimulation of a highly sensitive skin surface such as the tongue leading to problems of skin irritation or pain, and, following Lenay and colleagues (2003), (ii) because the portability of such devices is constrained due to the substantive energy consumption of the tactile stimulators. The Enactive Torch avoids both of these limitations since it only makes use of a single tactile output. This means that (i) it can make use of the special sensitivity of the hand without becoming intrusive, and (ii) has very little energetic requirements; these are incorporated into the device in the form of standard batteries. Moreover, the simplicity of the single distal-to-tactile transduction process makes a connection to a PC unnecessary, thereby further increasing portability. The Enactive Torch therefore matches the advantages sometimes conferred upon visual-to-auditory substitution devices (Auvray & Myin submitted), but has the added advantage of limiting the intrusiveness of the interface, which is especially true considering how important the auditory modality is for the blind. Indeed, in contrast to most sensory substitution devices, the Enactive Torch combines the input and output interface into one (handheld) component.

2.3. Limited bandwidth

The main philosophical objection to the Enactive Torch could be its simplicity. Surely, with the limited capacity of only one dimension of input and one dimension of output, the perceptual ability the device affords must be extremely limited? However, when philosophers question the engineering choices in this manner they are implicitly basing their argument on the premise that channel capacity determines perceptual resolution. Already a limited amount of exploratory use of the Enactive Torch makes it clear that this premise is not necessarily valid. Indeed, it turns out that, similar to the eye saccades that constitute visual perception, through active exploration with the device it is possible to generate a felt presence of the surrounding environment that transcends the direct physical stimulation of the hand. Moreover, it becomes evident that our nervous system is highly adapted to picking out significant sensorimotor correlations from a background of noise, since the occasional hardware glitches (i.e. false stimulations) are easily cancelled out by further exploration. Attention then shifts from the initial focus on the perturbation of the hand, to the contours of objects that appear in experience as present in the distant environment. The importance of embodied action for the constitution of perceptual objects thereby becomes accessible to direct experience, as the sensations from a device that is not used for active exploration are meaningless to the subject. The Enactive Torch is therefore a demonstration of how engineering can produce devices that, through their use, can induce changes in one's concept of perceptual experience.

3. Discussion

It is proposed that a philosopher's experience of interacting with devices like the Enactive Torch can play a critical role in the development of their concepts of experience. This role takes the form of two reciprocal loops. The first is the *use loop*, and is constituted by a philosopher's experience of interacting with the world using the Enactive Torch, reflection on such experiences, incremental or non-conceptual alteration of their concepts, and modulation of interactive modes as a result of these non-conceptual and conceptual developments. The second is the design loop, available only to a philosopher that plays a role in the design of the device. This loop is constituted by a interaction between experiences (both one's own and others') of using the device, changes in concepts involved in engineering/designing the device, changes in the actual design of the device, and the resulting impact such changes have on the experiences one has with the device. Of course, these two loops are not independent.

It should be stressed that the role of such experiences is not the same as the role of say, experimental observation in standard views of empirical science. On the orthodox view, an experiment is designed to test a (propositionally stated) hypothesis. The experiences that constitute the observational component of the experiment relate in a pre-determined, conceptually well-defined way to the hypothesis being tested. This is strikingly different from the role of experience emphasized by interactive empiricism, in which the experiences transform the conceptual repertoire of the philosopher, rather that merely providing eveidence for or against a proposition composed of previously possessed concepts.

4. Future work

Two methods of evaluation are being considered to test the effectiveness of the device with respect to the goals of interactive empiricism and conceptual change: first person phenomenological methods, and third person methods from the relatively new field of experimental philosophy.

- Initial steps for the first method have been taken undertaken recently by Petitmengin, who applied her interview techniques for eliciting detailed phenomenological descriptions (Petitmengin 2006) to a subject (Froese) who used the Enactive Torch in order to explore and attempt to recognize an object while blindfolded. The next step in this method is the development of techniques for analyzing the resulting transcripts so that cross-subject generalizations can be made. Other possible first person techniques that may be of use here include the Descriptive Experience Sampling Method (Hurlburt and Heavey 2006).

- Experimental philosophy (Nichols 2004) looks at the way in which subjects' philosophical views (usually conceived as something like degree of belief in a proposition) change as various contingencies related to the proposition change (e.g., how does the way one describes an ethical dilemma change subjects' morality judgements of the various actions in that situation?; cf, e.g. Knobe 2005). One could apply this technique directly, by empirically investigating how use of the Enactive Torch affects subjects' degree of belief in propositions concerning the nature of perceptual experience. However, it would be more in keeping with the insights of interactive empiricism if such experiments measured behaviour other than verbal assent to or dissent from propositions, such as reaction times and errors in classification behaviour. This might allow one to detect changes in subjects' conceptions of the domain that are not reportable or detectable by more propositional, self-reflective means.

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