Representation development, perceptual learning, and concept formation

doi:10.1017/S0140525X10002372

I. P. L. McLaren,[a] Andy J. Wills,[a] and S. Graham[b]
[a] *Washington Singer Laboratories, School of Psychology, University of Exeter, Exeter EX4 4QG, United Kingdom;* [b] *Clinical Imaging Research Centre, National University of Singapore, Singapore 117456*
i.p.l.mclaren@exeter.ac.uk **a.j.wills@exeter.ac.uk**
psysg@nus.edu.sg

Abstract: We argue for an example of "core cognition" based on Diamond and Carey's (1986) work on expertise and recognition, which is not made use of in *The Origin of Concepts.* This mechanism for perceptual learning seems to have all the necessary characteristics in that it is innate, domain-specific (requires stimulus sets possessing a certain structure), and demonstrably affects categorisation in a way that strongly suggests it will influence concept formation as well.

In *The Origin of Concepts* (Carey 2009), there is an in-depth examination and analysis of how we come to represent the world. The argument is that starting with both perceptual primitives and a newly-specified set of innate cognitive primitives labelled "core cognition," we are able to bootstrap ourselves to the point where complex, abstract symbolic constructs such as "momentum" and "kinetic energy" are available to us. But in framing this argument, Carey neglects, to some extent, a portion of her own work. This commentary will argue that in so doing she omits some of the best evidence for her claim that "core cognition" is a key component of concept formation.

In 1986 Diamond and Carey published an influential article ostensibly on face recognition, but in actuality on representation development as a consequence of experience. In "Why faces are and are not special: An effect of expertise," they make the case for the face inversion effect being, at least in part, a product of

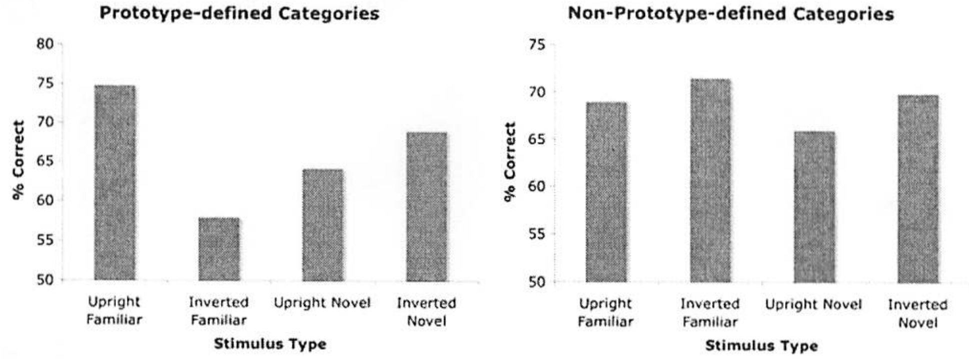

Figure 1 (McLaren et al.). The left panel shows results for the discrimination test after familiarisation with prototype-defined categories, the right results after familiarisation with the shuffled-row chequerboards. Adapted from McLaren et al. (1997).

experience with a category (faces of a given ethnic type) that possesses the requisite structure. This latter qualification refers to the idea that the category must be prototype-defined, in the sense that its exemplars vary in their second-order relational structure, and that this variation can, for present purposes, be loosely characterised as small deviations about the first-order relational structure defined by the prototype. Diamond and Carey (1986) made their case by showing that an inversion effect similar to that in faces could be obtained with certain classes of breed of dogs if the participants in the recognition experiment possessed the requisite expertise by virtue of being dog show judges of long standing. Novices, on the other hand, who were not as familiar with this category of stimuli, did not show a strong inversion effect.

We (McLaren 1997) have extended this result to abstract chequerboard categories defined by a prototype. In these experiments, randomly generated base patterns constructed from black and white squares (which served as prototypes) had noise added to them (some squares changed from black to white or from white to black) to create a number of exemplars of that category. Our participants were then trained to distinguish between two such categories, each defined by a different prototype or base pattern (i.e. between-category training), before being tested for their ability to discriminate between two members of a given category (i.e. a within-category test). The result was that discrimination was much better for the familiar categories than for exemplars taken from novel, control categories (Graham & McLaren 1998; McLaren et al. 1994), and this advantage was lost on inversion. We were also able to show that this result was not an inevitable consequence of familiarisation with a category constructed from chequerboards. By starting with base patterns as before, but then creating exemplars by randomly shuffling rows rather than randomly changing squares, we were able to create categories that could be discriminated just as easily as our earlier set, but when tested for within-category discrimination, participants were now no better on exemplars drawn from familiar categories than those drawn from novel categories, and there was no hint of an inversion effect. The results of one of these experiments (McLaren 1997, Experiment 1) are shown in Figure 1, and the necessary category type by familiarity by inversion interaction emerges to justify the assertion that the inversion effect is contingent upon familiarity with a category of the correct type. Our results, then, strongly support the Diamond and Carey thesis that inversion effects can be at least partly explained as a consequence of expertise with categories that have the requisite prototype-defined structure.

We have also shown (Wills & McLaren 1998) that categorisation does not require feedback for effective learning to take place (Fried & Holyoak 1984), and that this type of perceptual learning effect, that is, an enhanced ability to tell category members apart after familiarisation with the category if the category is prototype-defined, also occurs under these "free classification" conditions. It also leads to a different classification scheme (a change in the number of groups used). Therefore, the effect is not contingent on training via feedback, and we have considerable data indicating that it occurs as a result of mere exposure rather than as a consequence of any particular training regimen, (Suret & McLaren 2003; Wills et al. 2004); and in animals other than human (Aitken et al. 1996; McLaren & Mackintosh 2000).

If the innate ability of indigo buntings to identify the axis of rotation of the night sky is an example of domain-specific and species-specific animal core cognition, then surely the ability of humans to engage in this sort of representation development contingent on the appropriate stimulus input is an example of core cognition as well, and one that is directly relevant to concept formation. Here we have a domain-specific learning device tuned to a certain type of stimulus structure that undoubtedly influences categorisation in a manner that must have implications for conceptual representation. Therefore, we would argue that the "expertise" identified by Diamond and Carey (1986) is one of the best examples of core cognition in humans, and strengthens the thesis advanced by Susan Carey (2009).