

prehistoric hunter-gathering cave paintings. In the prehistoric “Grottes de Chargas” in the Pyrenees there are 217 such hands.

Experts agree that, whatever their function, these paintings incorporated and made use of accidental images in the bulges, fissures and scratches on the cave walls (Lorblanchet 1999). As Lorblanchet says “it is as if the caves were already inhabited by the spirits of the animals they knew.” Figure 7.2 shows a running ibex with legs from natural grooves in the wall from the “Grotte de Cougnac,” France.

In the “Grotte de Peche Merle” there is a beautiful horse with its head in a natural head-shaped rock formation. The shape of many animals follows the line of the relief structure of the wall. The “Grotte des Combarelles” (Les Eyzies, France) is a long tunnel into a hill decorated along its length with engraved animals inspired by natural forms on the rock walls. At the far end of the tunnel (and therefore nearest to the underworld) there is a single stencil of a child’s hand. The skill with which the natural rock structure is used is seen vividly when the guide switches off the electric lights in the tunnel and uses his cigarette lighter to imitate a prehistoric oil lamp. By its flickering light the shadows cast by the natural relief make the animals spring to life and seem to move.

But there are also places on the cave walls where our prehistoric ancestors’ animal images are mixed up with random finger marks in what was once soft clay (Figure 7.3). Thus palaeolithic artists had anticipated by 30,000 years Leonardo da Vinci’s theory of the deliberately untidy sketch: “For confused things rouse the mind to new inventions” (Gombrich 1966; McMahon 1956).

This history is relevant to design representation because our culture has provided us with many techniques for adapting our brains to new tasks in ways that we do not yet understand. Sketching is one such technique. In order to manipulate representations of imagined objects in working memory our brains appear to “borrow” temporary storage resources that evolved for recognizing and acting on real objects. Thus the fast-fade characteristics of short-term visual memory (Phillips and Christie 1977) is well adapted to the need to process without interference a stream of rapidly changing images from the



Figure 7.2 Ibex from the Grotte de Cougnac, France, 22,000 BP (from Clottes and Lewis-Williams 1996).



Figure 7.3 Grotte des Trois Frères, France. Detail from a wall of superimposed drawings and finger marks (from Clottes and Lewis-Williams 1996).

retinas of our moving eyes. The need to convert remembered form to the same structure and format as a sensed form in order to make a comparison is, I suggest, a key to an understanding of visual thought. When design becomes separated from manufacture we are forced to invent substitute stimuli that allow us to adapt visual resources to tasks for which they have not evolved.

However, just as the resources that are available to manipulate imagined objects without visual support are inadequate, so too our brains are poorly adapted to manipulate covertly verbally represented abstractions without external support. The capacity limit of four to seven “chunks” for verbal working memory is not enough to support complex sequential reasoning. Our inherited brains are well adapted by evolution to use stored knowledge to solve problems presented by immediately present sensory information or which demand immediate motor responses. But to manipulate stored information within our brains to solve problems about imagined future objects, our brains are forced to “borrow” resources that evolved for perceiving, acting and communicating. Hence the need for behavioural substitutes – representational systems that can be perceived and physically manipulated such as writing and drawing – and hence also the sense of “conversing with oneself” using notes or sketches.

Cultural Evolution: Sketches as Memes

I have tried to show that the two principal innate neural media that evolution has provided for thinking – language and mental imagery – are maladapted for design representation in a science-based culture. Undoubtedly, our Ice-Age ancestors needed to visualize immediately immanent events, how to strike a flint-tool, where to find new roots and berries, what to expect when hunting a mammoth. No identifiable design representations have been found among thousands of palaeolithic images. When design is concurrent with