making, the object itself supports the image. The prehistoric paintings and sculpture show that by 35,000 BP there was already a capacity to imagine important and familiar objects, but that this capacity was still tied to the visual system in the brain and needed visual support.

However, there is a major compensation for these disadvantages. Unlike that of any other primate, the human brain increases more than fourfold after birth (Bradshaw 1997). Despite very similar gestation periods, the brain of our nearest relative, the chimpanzee, increases only 60% after birth. Thus the human brain's capacity to learn and to change its connectivity in response to experience as it grows is much greater than that of any other species. Such postnatal neural flexibility is surely what has made cultural evolution possible. It allows our culture to provide "mind-tools" (Gregory 1981) to compensate for the time-lagged components of our brains. The biologist Richard Dawkins suggested that, because culturally acquired ideas and artefacts are reproduced by imitation and because such reproduction can also cause variation, such entities evolve by a process akin to Darwinian natural selection. He coined the term "meme" for such entities. "Memes" carried in our minds are supposed to be the controlling entities for cultural evolution as genes are for the evolution of our species. Dawkins (1976) argues that such "memetic evolution" acts on a much shorter time-scale than biological evolution and is not necessarily always to our benefit. Memes, like genes, are "selfish" in the sense that they exist only because they have been successful in being copied. "We are built as gene machines and cultured as meme machines" (ibid., p. 201). However, "we have the power to turn against our creators. We, alone on earth, can rebel against the tyranny of the selfish replicators" (p. 201).

Dawkins' idea has been enthusiastically developed by Dennett (1995) and by Blackmore (1999). I must confess that, even when developed at length, I find the idea of "memetics" as an explanation of cultural evolution to be rather muddled. It seems to me that it takes much more than a theory of behavioural imitation and selection to explain how our culture has produced Relativity Theory, Beethoven's Ninth Symphony, "Guernica," or, for that matter, Dawkins' theory of the meme. Genetic selection acts on random duplicating errors in our genes, but cultural selection acts on ideas that vary because they are modified by controlled experience and motivated thought. Nevertheless, I am prepared to accept the case that there are many components of human culture and behaviour that evolve by repeated imitation, without culture necessarily understanding how they work. One of the consequences of the theory is that the properties of memes are not necessarily those that are most useful to us, but those that cause them to be the most imitated. Such selfish components of our culture include the learned behaviour patterns that Gregory calls "mind-tools."[2]

So perhaps untidy sketching, or rather the idea of using incomplete or confusing percepts to stimulate mental imagery, is a meme that has evolved independently in different cultures. In hunter-gathering cultures natural or man-made untidy marks on rocks are used to create images for reasons already discussed. In historical times an independent evolution of the untidy sketch meme can be traced through the tradition starting with Leonardo da Vinci's advocacy of deliberate indeterminacy. "I have even seen shapes in clouds and on patchy walls which have roused me to beautiful inventions of various things, and even though such shapes totally lack finish in any single part they were yet not devoid of perfection in their gestures or other

movements" (Leonardo da Vinci in McMahon 1956). The meme has since been developed by imitation and selection by many others. An example of an intermediate "meme species" is the blotting technique used by Alexander Cozens for inventing landscape compositions (Cozens 1785). Another example is the technique invented, under Leonardo's influence, by Max Ernst, of using random pencil rubbings of patterns and textures to design his surreal "frottages." He remarked, "When I closely scrutinized the sketches thus made . . . I was amazed by the sudden intensification of my visionary capabilities and the hallucinatory result of the contrasting pictures" (Spies 1968). A similar tradition of using untidy images to stimulate invention evolved quite independently in the East (Rawson 1969).

Figure 7.4 shows an early sketch by Robert Venturi for the Sainsbury wing of the National Gallery in London. Clearly, a problem he had to solve was how to make the building look modern and, at the same time, to show its relationship to the existing neo-classical museum. He states that the main idea for the façade came on his second day in London as he was standing in Trafalgar Square. Whether deliberately or not, the sketch shows many of the indeterminacies advocated by Leonardo. In discussing the importance of drawing, Venturi refers to a "facility between hand and mind. Sometimes the hand does something that the eye re-interprets and you get an idea from it" (Lawson 1994). This reminds one of the finger marks made in the cave walls by prehistoric artists (Figure 7.3). Perhaps the shaman would have said, "Sometimes my hands move at random over the entrance to the underworld when suddenly by magic the spirit of an animal shows itself."

The ability to support the visualizing instinct with drawings or other incomplete percepts has never been treated as a necessary skill by our culture. It has remained a specialized meme used by artists and designers. In contrast, the memes for reading and writing are regarded today as obligatory support for the language instinct. Writing, mathematics, and other symbol systems are necessary to support the propositions, rules and reasoning that enables a technological culture to evolve. With the invention of printing, cultural evolution accelerated. However, for most of human history, the ability to read and write was the specialized skill of a minority of elite scribes. Only recently

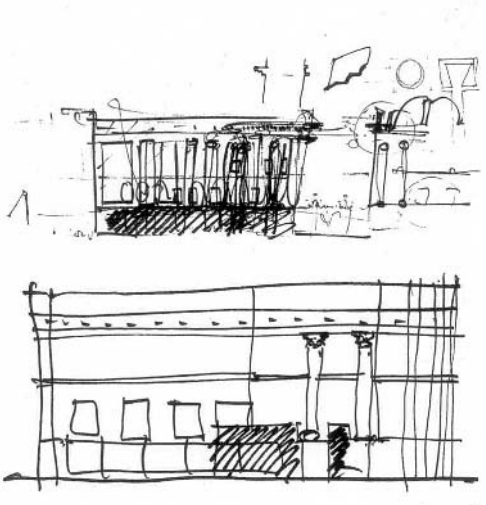

Figure 7.4 Robert Venturi, sketches (from Lawson 1994).