Everything is in the face

Cicero

1 Introduction

1.1 Subgoals, goals and limitations

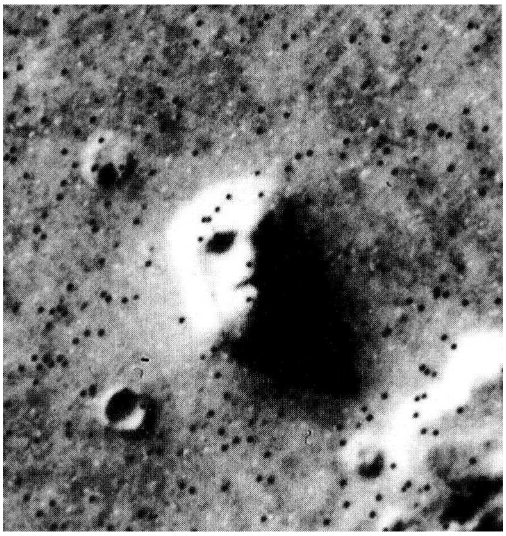
The use and benefit of human vision are complex and difficult to define, although we can confidently specify some minimal ones. Despite these, the visual system should be able to articulate and identify relevant objects like faces considering changes in their orientation and position in relation to other objects and to the observer. Moreover, it should be able to cope with changes in the amount or composition or position of the illumination in which the objects are viewed. In one word: *object constancy* seems to be a central goal of human vision; the organism has to abstract the stable properties of the world from the variable retinal image.
The present work specifically investigates the *processes* underlying the enormous performance of everyday life in recognizing faces. As virtually everyone is an expert in the recognition of faces, facial stimuli seem to be perfect material for examining such processes paradigmatically. Furthermore, the findings, thus achieved, may be ideally generalized to other domains of visual cognition. I will focus above all on the *early processing* in the recognition of faces, that is the first few hundred milliseconds, also called the pre-saccadic period, of the presentation of a stimulus. Within this time range, especially the reciprocal importance and interdependence of configural, holistic and featural information will be considered, and models of the recognition processes will be developed.

1.2 We cannot help seeing them: Our world is full of faces

Humans tend to interpret unidentifiable structures as faces. A popular example of this is the ‘man in the moon’—an illusion which is not only limited to western astronomical tradition, but is also well-known in ancient China and other cultures. Relatively recently, such a kind of illusion had a comeback with a picture made from the Mars surface by the Viking Orbiter 1 (frame nr. 070A13). As can be seen in Figure 1-1, the depicted mountain landscape can easily be interpreted as a face[1].

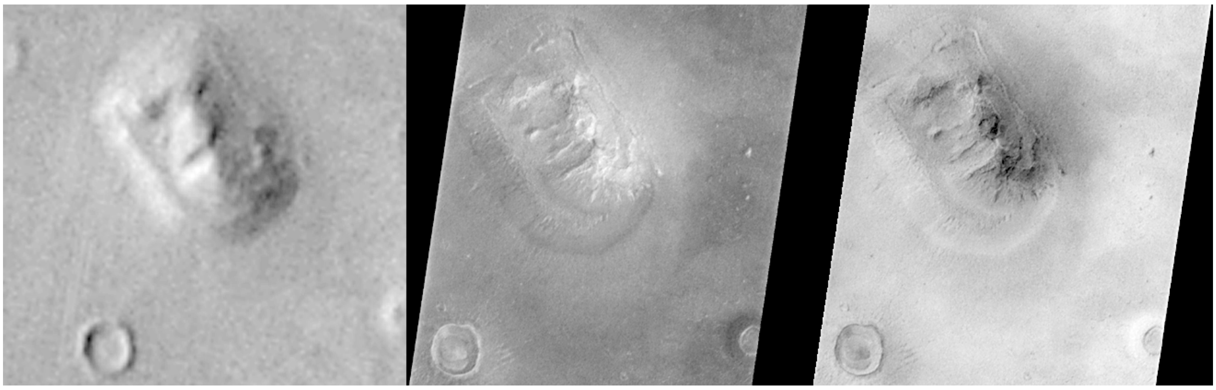
[1] As Palmer (1975) has pointed out, the hypothesis that nearly every object can be interpreted as a face can be extended to the everyday experience that almost any small shape can be seen as an eye, which seems to be the most distinct feature in the face (see section 3.1.1).

Figure 1-1: A picture made from the Mars surface by the Viking Orbiter 1 (McNeill, 1998, p.5).



However, as a more sophisticated technique was able to demonstrate the picture in question will be only interpreted as a face when the resolution and the contrasts are very poor. Some years later the National Aeronautics and Space Administration (NASA) took new photographs of this area with enhanced equipment. They could show that instead of a face only mountains could be seen (see Figure 1-2).

Figure 1-2: Three different versions of the same area of the Mars, scanned with different sensoric techniques. The left one is a variant of the picture shown in Figure 1-1, the middle image is a part of MOC frame 22003 shown normally, and the right image is the same MOC frame but with the contrast reversed (see http://mpfwww.jpl.nasa.gov/ for further details).



This tendency to see and interpret visual patterns easily as faces can also be demonstrated in psychological experiments. For example, Suzuki and Cavanagh (1995) showed clearly the strength of facial organization in grouping the constituent low-level features into a unitized face representation. The unitizing effect of facial organization is so strong that the mere arranging of three simple arcs in a facial organization defeats the global grouping of the non-target arcs and disrupts the parallel search for the oddly curved arc. These results are compatible with our daily experience of imagining faces in many inanimate objects, invariably in the front of cars and trucks and occasionally in rocks, clouds and landscapes. Wherever we look, someone seems to be looking back, like the famous man in the moon!
All these examples demonstrate that faces seem to play an extraordinary important role in our lives and for our visual system.

1.3 Importance of face recognition

Immanuel Kant pointed out that we can only know an object if we can represent it (cf. Kitcher, 1990). In the first edition of his *Critic of pure Reason*, he asked: “How is an object of representations possible?” (Kant, 1968, A104 et seqq.)[2], which is one of the central questions of cognitive psychology, still today. Although this task seems, in some respect, very minimal, it is complex in two ways: First, we have to encode objects such as faces into an effective but informative code. Second, we have to represent and organize them efficiently and addressable for further comparison and the process of recognition. Without the ability to recognize faces, we would not be able to establish any continuity of the actors of our social life, to identify and categorize people quickly, and, last but not least, we would not have a chance to diagnose any changes in a familiar face caused by illness, emotions, or aging. Additionally, many other information is supported by facial recognizing, particularly speech (Bruce & Young, 1986; Campbell & Massaro, 1997). For instance, McGurk and MacDonald (1976) demonstrated that the perception of a spoken sound is well supported by the interpretation of the facial gestures of the mouth. As a sum, many domains of pattern recognition are involved in beholding faces, most prominently face recognition and facial-affect perception.

1.4 Applications

The knowledge about and research on face recognition is not only of genuine psychological interest but is also applicable in many other ways. *To catch a thief* is presumably one of the most frequently cited applications. Many different visualizing techniques have been evaluated, particularly *Identikit* and *Photofit* (Shepherd, 1986; for a review Davies, 1981). Moreover, techniques of suitable police line-ups have been developed (Valentine, Harris, Colom Piera, & Darling, in press; Valentine & Heaton, 1999). Even more sophisticated techniques for identifying a previously seen face, for instance mathematical models including psychological evidence, are now available (Rakover & Cahlon, 1989). In the *Catch Model, s*ubjects are presented with a pair of test faces on each trial. Neither of the test faces is thereby the target face. The subjects’ task is to choose from the two faces the one most similar to the target face. As a result, a picture of the target is built up, being a composite of the preferred pictures. A progressed version of the *Catch Model* with a differentiated weighting of the different features was presented in Rakover and Cahlon (1998).
Another important issue is the usage of knowledge about face recognition for biometrical identification systems (cf. Rao & Ballard, 1995). Systems working very fast and automatically are becoming more and more popular, and the need for accurate performance is increasing immensely (Intrator, Reisfeld, & Yeshurun, 1995) due to the great security requirements of governments, companies and organizations.
Moreover, animated faces are used as artificial agents for information services or in modern movies. Furthermore, it is important to develop secure devices for biometric identification systems in cash machines.

[2] Originally published in 1781 (first edition, so-called ‘A-edition’).