8 Saccadic Eye Movements and Visual Stability: Preliminary Considerations Towards a Cognitive Approach

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1 Introduction

The images of the objects projected on the retina move with every saccade. Yet, we perceive these objects as stationary, i.e., we neither perceive the objects as moving during the saccade (dynamic component) nor do we perceive them as displaced as a result of the saccade (static component). This is the phenomenon of visual stability, which has been extensively studied since Helmholtz' (1866) early work (for overviews see Dolezal, 1982; Festinger & Cannon, 1965; Gyr, 1972; MacKay, 1973; Matin, L., 1972, 1982; McClosky, 1981; Shebilske, 1977).

As has been emphasised by Shebilske, the dynamic and static components of visual stability are independent from one another: If a target light is exposed in an otherwise dark field, a "retinal smear" caused by the fast movement of the target across the retina can be seen (e.g., Mitrani, Mateeff, & Yakimoff, 1970), although the perceived location of the target light remains invariant before and after the saccade. Thus, under dark field conditions only the static, but not the dynamic, component of visual stability is preserved.
The dynamic component of visual stability depends on stimulus conditions, e.g., contrast ratio (Shebilske, 1977), and is thought to be caused by predominantly peripheral mechanisms, such as visual masking (Matin, E., 1974). By contrast the mechanism underlying the static component of visual stability seems to be of more central origin. How this mechanism works is still under debate.

In the present paper a cognitive approach to the static component of visual stability is outlined. In the first section I argue that, contrary to the Gibsonian position, visual stability cannot be explained without the concept of extraretinal information. The next section contains a brief discussion of the classic cancellation theories, which assume that the extraretinal information used in producing visual stability is provided by the motor system. In the subsequent sections the new theoretical viewpoint is presented, based on the assumption that the extraretinal information is not of motor, but of cognitive origin.

2 Some Definitions

The phenomenon of visual stability may be described in more precise terms by using the following definitions:

The physical object in the environment is called the *environmental object*. Its location and displacement in environmental coordinates define its *environmental location* and *environmental displacement*, respectively. The optical projection of an environmental object on the retina is called the *retinal stimulus*. Its location and displacement in retinal coordinates define the *retinal location* and *retinal displacement*, respectively. The total pattern of all retinal stimuli is called the *retinal image*. The term *exafferent retinal displacement* refers to a retinal displacement produced by an environmental displacement. A retinal displacement produced by a saccade is called *saccadic retinal displacement*. The perceived position and displacement of an object in coordinates of visual space are called *visual location* and *visual displacement*, respectively.

Using these definitions, the phenomenon of visual stability can be described as follows: Every saccade produces a retinal displacement of each retinal stimulus. These retinal displacements could also have been caused by appropriate environmental displacements with the eyes held stationary. Yet, saccadic retinal displacements do not lead to visual displacements, whereas exafferent retinal displacements do. This does not mean that saccades do not affect perception at all. What they change is *perceived gaze direction* (Gibson, 1966, 1968; Dolezal, 1982). Thus, both kinds of retinal displacements have their specific effects: Exafferent retinal displacement leads to visual displacement, saccadic retinal displacement causes a shift in perceived gaze direction.