Transduction in Photoreceptors with Bistable Pigments: Intermediate Processes*

Baruch Minke

Department of Physiology, Hebrew University Hadassah, Medical School Jerusalem, Israel,
Max-Planck-Institut für biologische Kybernetik,
D-7400 Tübingen, Federal Republic of Germany

Abstract. The prolonged depolarizing after potential (PDA) in the R1–6 receptors of the fly was used to isolate intermediate processes in phototransduction which are not manifested directly in the voltage response. It is first demonstrated that a pigment shift by light from metarhodopsin to rhodopsin in four species of the flies: *Drosophila*, *Calliphora*, *Chrysomya* and *Musca* induces an independent antagonistic process to the PDA, which is manifested in a strong inhibitory effect on PDA induction and is called the anti-PDA.

By using mutants of *Drosophila* the existence of processes underlying the PDA were examined. The norpA and the trp mutant were used in which the voltage response of the photoreceptors could be reversibly abolished by elevated temperature and long intense light respectively. It is shown that the excitatory process underlying the PDA could be induced and depressed in conditions that block the voltage response of the photoreceptors, thus indicating the existence of intermediate processes which link the pigment activation by light to the PDA voltage response.

Key words: PDA — anti-PDA — Drosophila mutants — Phototransduction.

Introduction

The receptor potential is a step in a cascade of events which are initiated by the absorption of photons by the visual pigment molecules. The nature of these events is largely unknown.

In this research we were interested in isolating processes which occur before the initiation of the photoreceptors voltage response but after the activation of the visual pigment. For this purpose we used a certain voltage response which is found in many invertebrates and called the prolonged depolarizing afterpotential (PDA). The PDA has several characteristics which make it very convenient for studying phototransduction (Hillman et al., 1977). The PDA is induced by an illumination that causes a net shift of pigment from rhodopsin (R) to its long lived photoprod
metarhodopsin (M) (Hochstein et al., 1973). It is manifested in a depolarization which in the dark decays spontaneously very slowly, long after the pigment shift from R to M took place. But it can also quickly be depressed at any time by shifting the pigment back from M to R (Nolte and Brown, 1972; Muijser et al., 1975; Minke et al., 1975a; Tsukahara et al., 1977).

A question arises whether the process underlying the PDA depression is just the reversal of the excitatory process underlying PDA induction or a separate independent antagoistic process. In the barnacle (Hochstein et al., 1973) and in the UV receptors of the *Limulus* median eye (Minke et al., 1973), where the PDA is usually not longer than 1 h, it had been demonstrated that a net M to R pigment shift, after the spontaneous decay of a maximal PDA, resulted in a period in which the induction of the PDA was strongly inhibited (Hochstein et al., 1973; Minke et al., 1973).

![Figure 1](https://example.com/figure1.png)

Fig. 1. (Legend see page 165)