Introduction

Retinal ganglion cells (RGCs) are output neurons that convey visual information from the retina to higher visual centers in the brain. They consist of 10-12 cell types with distinct structure and function in mammalian retinas (Masland, 2001; Wassle, 2004). These different RGC types represent multiple parallel pathways in which various visual signals are encoded separately. In rabbits, 11 ganglion cell types have been systematically characterized, and each of them possess strikingly varied dendritic architecture (Rockhill et al., 2002). These diverse morphological properties of adult RGCs provide an accessible system to study mechanisms that regulate dendritic development (Wong and Ghosh, 2002).

In vertebrate retinas, RGCs start a period of active dendritic growth in the early stage, extending numerous spines and branching diffusely. RGCs then continue with interstitial growth which no new branches and growth cones are formed in the late stage (Maslim et al. 1986). Both intrinsic and extrinsic factors are involved in regulating dendritic development of RGCs. Although the initial cell fate determination and morphological differentiation is genetic programmed, RGCs undergo significant dendritic growth and remodeling after birth (Robinson, 1991). Several extrinsic influences have been proposed, including target-dependent factors, neighbor interactions, and afferent signaling (Sernagor et al., 2001). While the source of afferent neurotransmission is not clear, visual stimulation through glutamatergic transmission may play a significant role in regulating dendritic development.

It has been well established that visual experience has a great impact on visual system development in the brain. However, it is not certain whether visual experience exerts similar effects on the dendritic maturation of RGCs. It has been shown that chronic rearing in darkness cause almost complete loss of RGCs in chimpanzees (Chow, et al.

1957). In addition, dark rearing extends the period of spontaneous activities in RGCs, and results in an enlargement of receptive field and dendritic field of RGCs in the turtle retina (Sernagor and Grzywacz, 1996). Early light stimuli after eye opening promote loss of ON-OFF responsive RGCs and segregation of ON/OFF layers in the IPL of the mouse retina (Tian and Copenhagan, 2003). Furthermore, dark rearing exerts a reversible suppression on the oscillatory potential of electroretinogram (ERG) and the spontaneous excitatory and inhibitory currents in the mouse retina (Tian and Copenhagan, 2001; Vistamehr and Tian, 2004). In contrast, in hamsters, visual deprivation has no significant effect on the morphological features of type I RGCs (Lau et al., 1990). Dark rearing maintains complexity of dendrites of aberrant RGCs and remains the soma area and dendritic area unchanged in hamsters (Wingate and Thompson, 1994). In cats, monocular suture does not affect the dendritic field and the branch pattern of alpha and beta RGCs (Leventhal et al., 1983). The ERG responses of the dark-reared rabbit retinas do not differ from of the normal ones (Reuter, 1976). Taken together, the effect of light deprivation on the retinal neuron development appears to be species specific.

In this study, we examined whether visual stimulation can influence the morphological maturation of RGCs in the rabbit retina. We chose rabbits aged postnatal days 20 to 22 (p20~p22) because it is the time when the functional circuitry of retina has attained (Masland, 1977). To visualize the morphology of individual RGC, we labeled RGCs by using a recently developed ballistic technique with lipophilic fluorescent dye (Gan, et al., 2000; O'Brien and Lummis, 2004; Connaughton et al., 2004; Sun et al., 2002). RGCs were randomly stained by rapidly shooting dye-coated particles. We compared the dendritic fields of labeled RGCs under both the normal light-dark cycle and the complete dark conditions. The result shows that light experience does not influence the development of dendritic field size of RGCs in the rabbit retina.