

摘要

先前的研究指出，約在兔子睜開眼睛的時期，兔子視網膜節細胞就能對光刺激產生反應，在這個發育階段，視網膜節細胞已展現一些生理特性（例如感受域的中心結抗性）。然而在兔子開眼後，視網膜節細胞會持續經歷細胞形態改變，以及感受域的微調整。因此本研究主要在檢視發育過程中，視網膜節細胞的生理功能和形態特性，並嘗試研究兩者之間的關係。從分屬三個不同發育時期的紐西蘭白兔取得實驗所用的視網膜後，利用白噪音視覺刺激引發視網膜節細胞反應，由胞外記錄的方式量測，經分析可得到觸發神經衝動的平均刺激，以代表視網膜節細胞的時空感受域。其後利用染劑注射視網膜節細胞，得到細胞形態來和平均刺激的空間結構互相比較。結果顯示，平均刺激的時間特性，會漸進地成熟；在出生後約兩週到三週、及三週後，alpha 視網膜節細胞所需對光刺激的整合時間，會逐漸減少。此外，對於光刺激產生穩定反應的能力，也會在出生後三週左右發生調整。然而，平均刺激的空間結構，和細胞樹突密度的關連程度不高，發育過程中也無明顯改變。所以本研究的結果顯示，視網膜節細胞的一些生理功能，在動物開眼後仍會繼續發育，但和細胞形態的微調無關。既然已知哺乳類視網膜中的緞帶突觸，會在相近的發育階段趨於成熟，因此，這些視網膜生理功能的改變，很可能是和緞帶突觸的發育有關。

關鍵字：視網膜節細胞，感受域，發育

Abstract

Previous studies showed that rabbit retinal ganglion cells (RGCs) are responsive to light stimuli at around eye opening (postnatal day P10-11), and some of their physiological features (e.g., concentric receptive field antagonism) are also present at this developmental stage. However, active morphological remodeling of RGCs and fine tuning of their receptive fields are still continuing to proceed after eye opening. Thus, I investigated the physiological and morphological properties of RGCs throughout development, and attempted to examine the correlation between these two aspects. Ganglion cells from isolated retinas of New Zealand White rabbits were studied at three postnatal stages. The spatiotemporal receptive field properties of the alpha RGCs were characterized using the white noise stimuli, and the corresponding spike triggered average (STA) results were analyzed. After extracellular recording, the alpha cells were injected with dye to allow a direct comparison between the morphological pattern and their spatial STA profiles. The results showed that the maturation of STA time course is a gradual process during the development, that is, alpha RGCs gradually decrease their stimulus integration time from P10-14 to P20-23 then to adult. In addition, the robustness of the alpha RGC response to light stimulation is also developmentally modulated, and its main effect occurs before P20. Furthermore, moderate correlations between spatial STA

profiles and dendritic densities of both ON and OFF alpha RGCs do not change throughout development. Taken together, these results support that some functional properties of RGCs are indeed still developing even after eye-opening, and reveal that the morphological refinement of RGCs is independent of their physiological maturation. Given the fact that the ribbon synapses also develop at the same stages in the mammalian retina and their involvement in regulating response dynamics, it is likely that the changes of some functional properties of RGCs depend on the development of ribbon synapse.

Key words: RGC, receptive field, development

