Ganglion cell adaptability: Does the coupling of horizontal cells play a role?

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It's well known that the visual system can adjust itself to different visual environments. A classic example of this is the shift in spatial frequency sensitivity that occurs with the change from night (scotopic) to day (photopic) vision. This shift serves presumably as an information-optimizing strategy: at night i.e., under photon-limited conditions, where the signal-to-noise ratio is low, the visual system is better served by integrating over a large area, so it shifts its tuning toward low spatial frequencies. During the day, when photons are not limiting, the system is better served by integrating over smaller areas, so it can resolve image details; in this case, the shift is toward high spatial frequencies (van Hateren, 1992).

How the visual system performs this shift is not clear. A large body of evidence, though, points to the retina as the starting point since the shift is detectable at the level of the retinal ganglion cells (Barlow et al., 1957; Maffei et al., 1971; Muller and Dacheux, 1997. What remains to be determined is the mechanism that confers this ability on these cells. The working hypothesis is that a change in ganglion cell receptive field surround size occurs and is mediated by a change in the gap junction coupling of horizontal cells. Here we tested this hypothesis: we measured the change in spatial frequency sensitivity using a transgenic mouse line that has essentially no horizontal cell coupling (a connexin57-deficient line, in which horizontal cell coupling is > 99% abolished) and compared it to the same in wild type controls. Measurements, both at the level of ganglion cell responses and the level of behavioral performance, showed that the coupling and uncoupling of horizontal cells does not play a role in spatial tuning and its adjustability. Instead, our data suggest that another mechanism, likely arising in the inner retina, must be responsible.

C.P. and K.D. contributed equally to this work.

References:

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