

POSTER PRESENTATION

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Local interaction in retinal ganglion cell mosaics can generate a consistent spatial periodicity in cortical functional maps

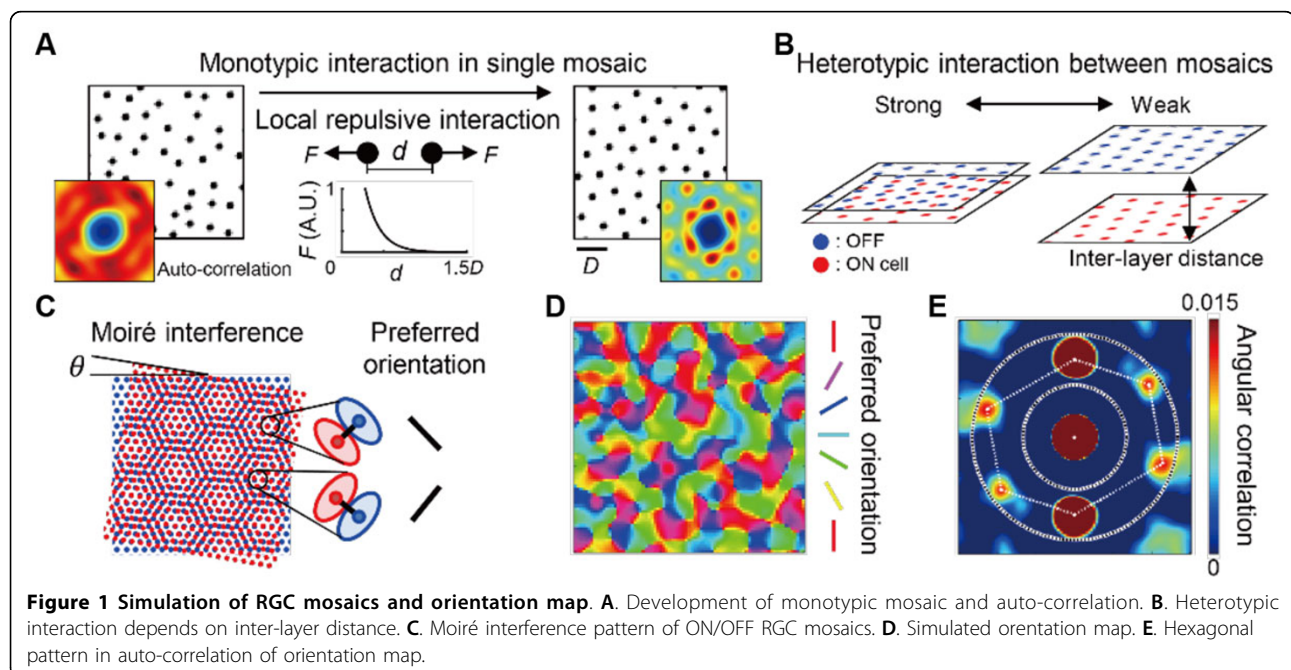
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Orientation map is one of the most studied functional maps in visual cortex, but the developmental mechanism of its consistent spatial periodicity is still elusive. Recently, a theoretical model suggested that a moiré interference pattern between ON and OFF retinal ganglion cell (RGC) mosaics can develop a quasi-periodic orientation map, but it is remained unclear how this can explain the constant periodicity of the maps [1]. Here

we suggest a developmental model that a simple local interaction in RGCs can generate a consistent spatial periodicity of orientation preference, by inducing (i) a hexagonal lattice structure in ON/OFF RGC mosaics and (ii) a constant alignment angle between them.

First, we introduced a developmental model of a monotypic RGC mosaic to show that a local repulsive interaction can generate a hexagonal structure (Figure 1A).



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Previously, in the model study of the pairwise interaction point process, it was suggested that a local interaction alone cannot develop a long-range order in the mosaic structure [2]. We assumed a different type of local repulsive interaction that the cell positions can be gradually shifted by a repulsion from the neighbor cells and confirmed that this model can develop a long-range ordered structure that is well fitted to a hexagonal lattice.

Next, we assumed that there also exists a heterotypic repulsive interaction between ON and OFF RGC mosaics and examined how this can affect the alignment between the two mosaics (Figure 1B). When the inter-layer distance between ON/OFF mosaics was varied within a proper interval, the hexagonal structure was preserved in each mosaic, but the alignment angle (θ) between the two mosaics was restricted within a certain range of angles, and this induced a constant spatial periodicity in the ON/OFF interference pattern (Figure 1C). As observed in the moiré interference, we confirmed a consistent hexagonal periodicity in the cortical orientation map that are simulated by statistical wiring model from the developed RGC mosaics (Figure 1D,E) [3].

Conclusions

Our result suggests that a local repulsive interaction in RGC mosaics can generate a hexagonal structure in ON/OFF RGC mosaics and a restricted alignment between them. The interference between mosaics induces a consistent spatial periodicity in cortical orientation map as predicted by the moiré interference pattern.

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