# Identifying temporal population codes in the retina using canonical correlation analysis

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Right from the first synapse in the retina, the visual information gets distributed across several parallel channels with different temporal filtering properties (Wässle, 2004). Yet, the prevalent system identification tool for characterizing neural responses, the spike-triggered average, only allows one to investigate the individual neural responses independently of each other. Here, we present a novel data analysis tool for the identification of temporal population codes based on canonical correlation analysis (Hotelling, 1936). Canonical correlation analysis allows one to find `*population receptive fields*' (PRF) which are maximally correlated with the temporal response of the entire neural population. The method is a convex optimization technique which essentially solves an eigenvalue problem and is not prone to local minima.

We apply the method to simultaneous recordings from rabbit retinal ganlion cells in a whole mount preparation (Zeck et al, 2005). The cells respond to a 16 by 16 pixel m-sequence stimulus presented at a frame rate of 1/(20 msec). The response of 27 ganglion cells is correlated with each input frame in an interval between zero and 200 msec relative to the stimulus. The 200 msec response period is binned into 14 equal-sized bins. As shown in the figure, we obtain six predictive population receptive fields (left column), each of which gives rise to a different population response (right column). The x-axis of the color-coded images used to describe the population response kernels (right column) corresponds to the index of the 27 different neurons, while the y-axis indicates time relative to the stimulus from 0 (top) to 200 msec (bottom). The six population receptive fields do not only provide a more concise description of the population response but can also be estimated much more reliably than the receptive fields of individual neurons.

In conclusion, we suggest to characterize retinal ganglion cell responses in terms of population receptive fields, rather than discussing *stimulus-neuron* and *neuron-neuron* dependencies separately.

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