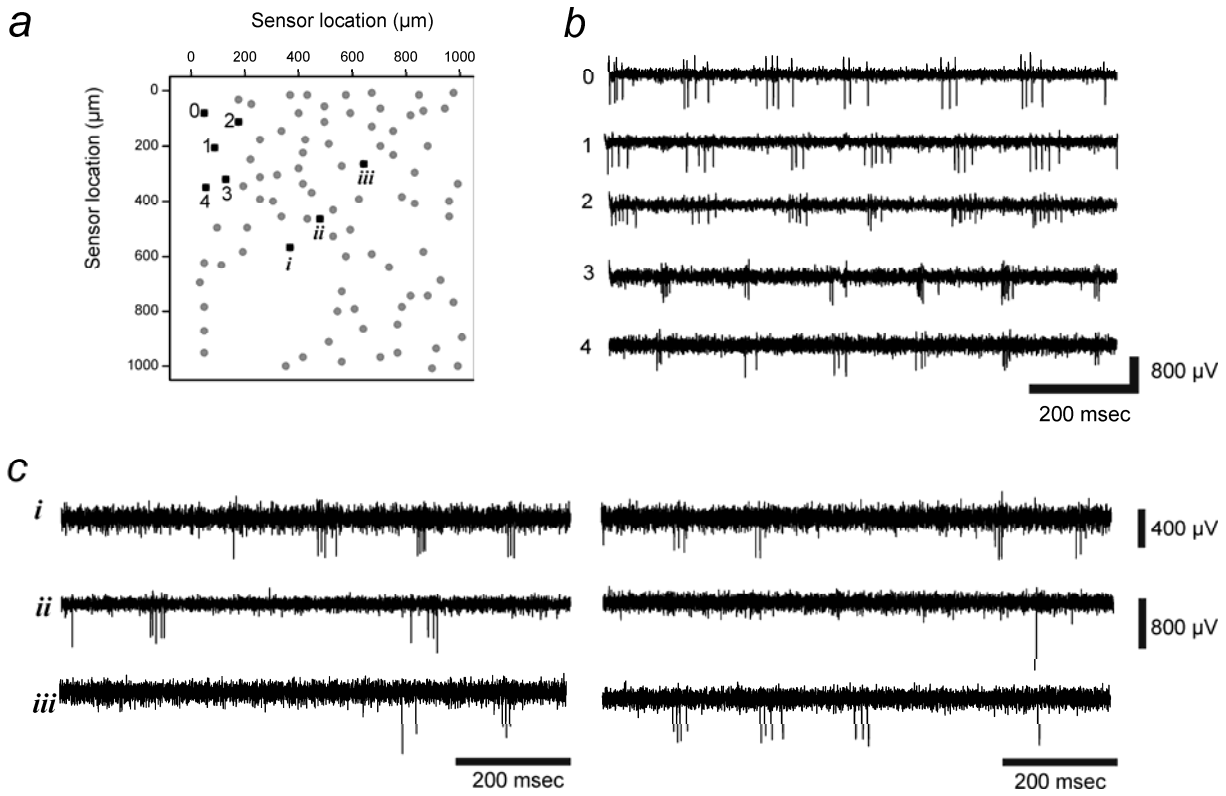


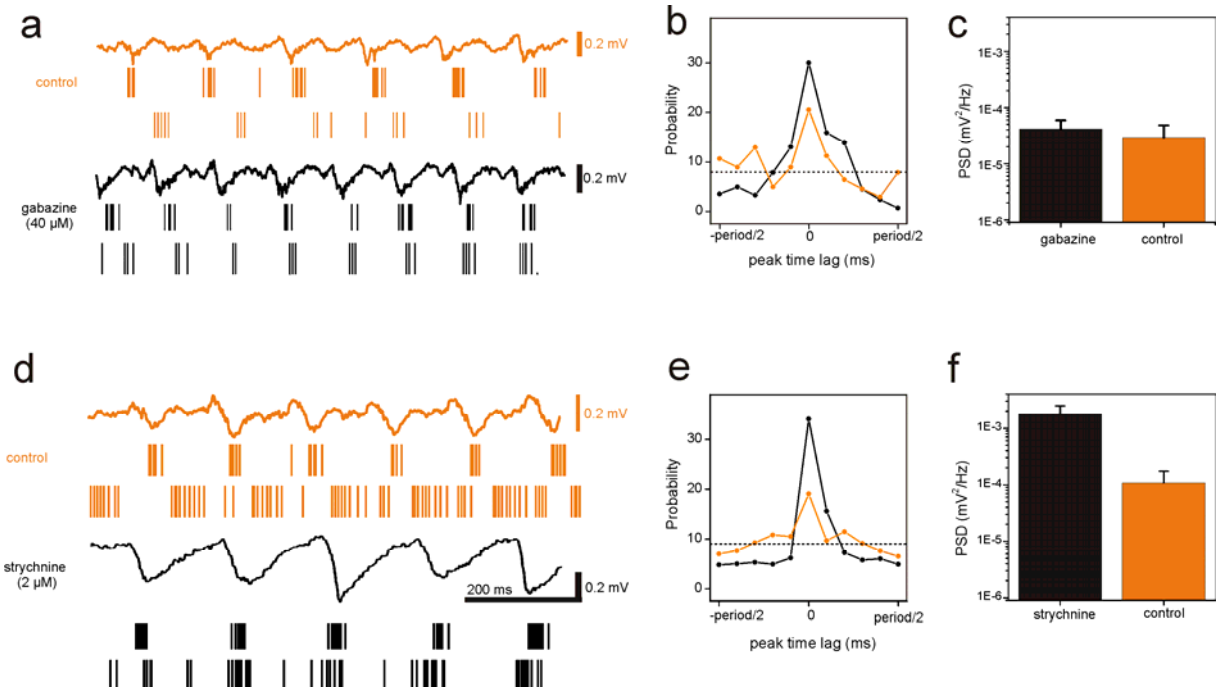
Supplemental Figure 1: Calibrated voltage traces of selected nearby *rd1* RGCs exemplify the nature of rhythmic activity

(a) The sensor positions that recorded *rd1* RGCs in one retinal portion (selected spike times are shown in **Fig.1** of the main text). These positions were assigned to the corresponding ganglion cells by the custom-written spike-sorting program. Calibrated voltage traces at selected sensor positions are shown in (*b*) and (*c*)

(b) Calibrated extracellular voltage traces from five nearby RGCs.

The spike trains shown in trace 1 and trace 2 display synchronous activity (**Fig 1c, d**) while the spike trains calculated for the cells 1 and 3 display phase-shifted activity (**Fig 1c, d**). The data presented here were simultaneously recorded for all five cells.

(c) Extracellular voltage traces of three RGCs that did not display rhythmic activity throughout the recording time. The three simultaneous traces in the left panel were recorded at the same time as the cells shown in (b) but at a different time than the three simultaneous traces in the right panel.



Supplemental Figure 2: Inhibition of GABAergic or glycinergic receptors increases the synchronization among *rd1* RGCs and the LFP amplitude.

(a-c) Effect of gabazine (SR-95531 hydrobromide, 40µM) on RGC spiking and LFPs in *rd1* retinas.

(a) *Upper traces (orange):* LFP(first row) and corresponding RGC spiking (second row) in an untreated *rd1* retina. The third row represents the spiking of another RGC in the same retina. *Lower traces (black):* LFP and RGC spiking recorded on the same sensors as shown above after the application of gabazine.

(b) Average probability distribution of minimum time lag of the central spike train cross-correlogram (CC) peaks under control conditions (orange) and with $GABA_A$ receptors blocked (black). The distributions are averaged for CCs of RGCs from two retinas. See corresponding **Fig.6e** in the manuscript.

(c) Average LFP peak power measured on 20 sensors before (orange) and after (black) the application of gabazine. Although gabazine increases the LFP amplitude, the effect is not significant (p=0.07).

(d-f) Effect of strychnine (2 µM) on RGC spiking and LFPs in *rd1* retinas.

(d) LFP and RGC spiking before (orange) and after (black) the application of strychnine. Details as in (a).
(e) Average probability distribution of minimum time lag of the central spike-train CC peak under control conditions (orange) and with glycinergic receptors blocked (black). The distributions are calculated for CCs of RGCs from two retinas. See corresponding **Fig.6e** in the manuscript.
(f) Average LFP peak power measured on 20 sensors before (orange) and after (black) the application of strychnine. The peak of the LFP power spectral density increases by an order of magnitude in the presence of strychnine.