

**Figure 2** Nonlinearity accounts for much of decorrelation. **(a,b)** Spatial correlation functions for neurons and models under naturalistic stimulation. Cells with the same polarity preference (OFF-OFF or ON-ON pairs) have positive correlations **(a)** and those with opposite polarity preferences (OFF-ON pairs) have negative correlations **(b)**. Curves are presented as in **Figure 1h** for the stimulus, trial-averaged firing rates, spike trains and linear models. The stimulus correlations are shown with opposite sign for ease of comparison in **b**. Results from many cell pairs are summarized by the median correlation for pairs at similar retinal distance; error bars indicate the central quartiles. L: center and L: center-surround designate linear models using receptive fields including the center component only or both center and surround. **(c)** The origins of decorrelation in different response components. The full circle represents the median correlation present in the stimulus after filtering by the receptive field centers at a retinal distance of 300  $\mu\text{m}$  (arrowheads in **a**). The empty wedge (C) is the much smaller remaining correlation between the ganglion cell spike trains. The red wedge represents the decorrelation caused by lateral inhibition from receptive field surrounds. The difference between the linear response and the observed firing rate is a result of nonlinear processing and is responsible for over half the decorrelation implemented by the retina (green wedge). The trial-to-trial variation contributes an additional small amount of decorrelation (blue wedge). **(d)** Decorrelation in the time domain. Autocorrelation functions of salamander ganglion cell responses and linear models are plotted as a function of delay during naturalistic stimulation. The linear filter's first lobe,  $\sim 100$  ms wide (inset, black), introduced excess correlation beyond that in the stimulus. The antagonistic second lobe (inset, red) counteracted those, but overcompensated, introducing anticorrelations at long delays. The observed correlations in the firing rate were much smaller still. **(e,f)** Spatial **(e)** and temporal **(f)** correlations in macaque RGCs, displayed as in **a**, **b** and **d**. Macaque RGC responses were approximated by an LN model<sup>13,23</sup>, using published spatio-temporal receptive field parameters<sup>36</sup> (equations (4–6)) and sigmoidal nonlinearities<sup>23</sup> (equation (10)). The output noise was modeled as sub-Poisson variation (equation (11)) with parameters derived from published spike trains<sup>21</sup> (see Online Methods). The stimulus was scaled in space and time to compensate for the different scales of primate and salamander receptive fields. L, receptive field filter only; LN, including the nonlinearity; LN + noise, including the noise.

