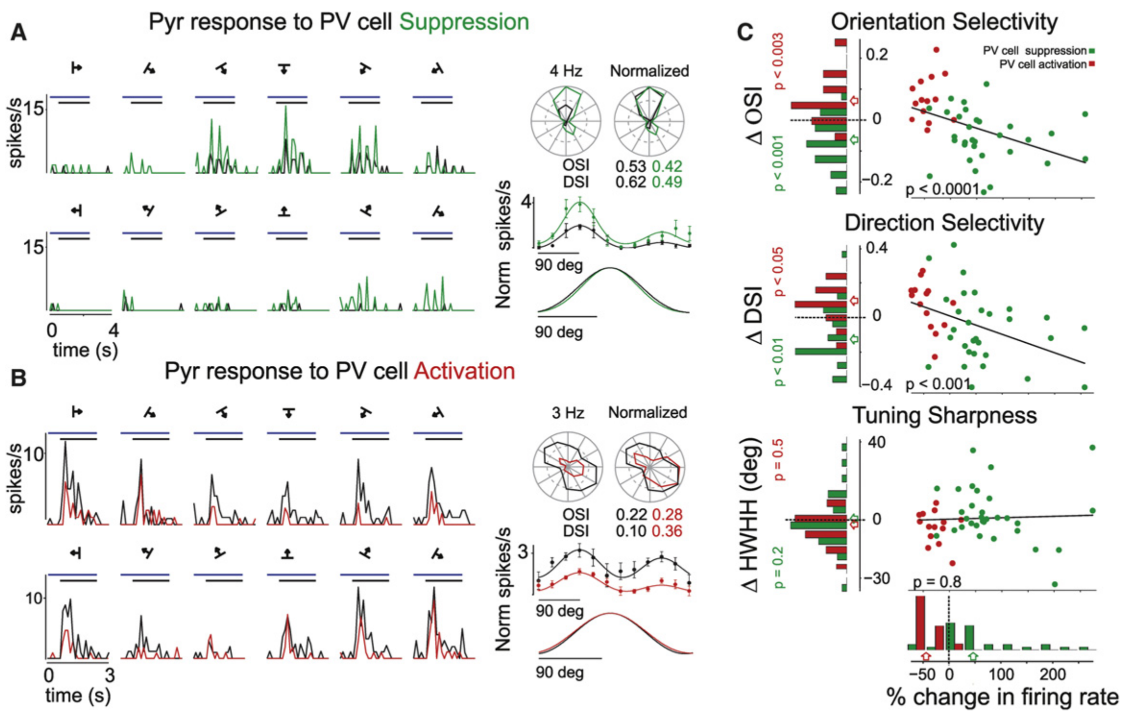


**Figure 3. Slight Modulation of Pyr Cell Tuning Properties by PV Cells**

(A) Left: PSTH of Pyr cell response to drifting gratings during control (black) or Arch-mediated suppression of PV cells (green). Horizontal bars: black, stimulus presentation; blue, LED illumination. Right: the tuning of the cell is illustrated on polar (top) and Cartesian (middle) axes (black: control; green: PV cell suppression). The tuning curves plotted on Cartesian axes are fitted with a double Gaussian. Note the slight reduction in both orientation and direction selectivity indexes. Bottom: the Gaussian fits under control (black) and PV cell suppression (green) are normalized to the peak and superimposed for comparison. Error bars are the SEM. Note that the tuning sharpness during PV cell suppression remains essentially unaffected.

(B) Left: PSTH of Pyr cell response to drifting gratings during control (black) or ChR2-mediated activation of PV cells (red). Horizontal bars: black, stimulus presentation; blue, LED illumination. Right: the tuning of the cell is illustrated on polar (top) and Cartesian (middle) axes (black: control; red: PV cell activation). The tuning curves plotted on Cartesian axes are fitted with a double Gaussian. Note the increase in both orientation and direction selectivity indexes. Bottom: the Gaussian fits under control (black) and PV cell activation (red) are normalized to the peak and superimposed for comparison. Error bars are the SEM. Note that the tuning sharpness during PV cell activation remains essentially unaffected.

(C) Linear regression (line) of percentage change in Pyr cells firing rate at their preferred orientation versus the change in their tuning properties during PV cell photo suppression (green dots; n = 31) or PV cell photo activation (red dots; n = 14). p values (black) indicate the significance of correlation between in change firing rate and tuning property. Left: distributions of respective tuning properties (negative values indicate decrease in tuning property; p value indicates confidence that there is a significant difference; green: Arch versus control; red: ChR2 versus control). Bottom: distribution of change in firing rate. Arrows point to population medians.

in synaptic inhibition and indirect increase in excitation. This indirect effect results from the fact that cortical Pyr cells within layer 2/3 are recurrently connected; thus, an increase in firing rate of Pyr cells in response to PV cell suppression (as observed above) may lead to an increase in the amount of excitation received by the Pyr cells themselves.

To quantify the net decrease in visually evoked inhibition during Arch-mediated suppression of PV cells we recorded in the whole-cell voltage-clamp configuration from layer 2/3 Pyr cells (targeted with two-photon microscopy) using a Cs-based internal solution. When the membrane potential of Pyr cells was clamped at the reversal potential of glutamate-mediated synaptic excitation (~15mV), photo suppression of PV cells decreased by 10% the postsynaptic inhibitory currents evoked by visual stimuli in Pyr cells (−9% ± 20%; n = 13 cells, $p < 0.03$; Figure 5A). To quantify the impact of PV cell suppression on excitation, Pyr cells were voltage clamped at the reversal potential for $GABA_A$ receptor-mediated inhibition (−80mV). Photo suppression of PV cells led to a small but significant increase in spontaneous excitatory conductance (0.1 ± 0.02 nS; n = 10; $p < 0.004$), demonstrating that our recordings are indeed sensitive to changes in excitation. However no significant increase was measured in visually evoked excitatory conductance (n = 10; p = 0.5; Figure 5B). Thus, PV cell suppression results in little change in excitation but a net decrease in synaptic inhibition on to Pyr cells.

## A Conductance-Based Model Captures How PV Cells Transform Pyr Cell Responses

Can this relatively small decrease in inhibition explain the observed linear transformation of Pyr cell spiking activity? To test this we constructed a simple conductance-based model of Pyr cell spiking activity and studied its dependence on stimulus orientation. To fully capture the linear transformation, not