The spike timing-dependent influence of intrinsic long-range connectivity over post-natal topographic organization in primary visual cortex

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For over two decades, models applied to the problem of topographic map development in sensory cortex have assumed that intrinsic long-range connectivity plays an important role in the activity-dependent refinement of these maps [1-3]. However, there is a large body of experimental evidence demonstrating that input provided via these connections is predominantly subthreshold (or only weakly suppressive), and therefore unlikely to be able to significantly influence an activity-dependent process of this kind. The objective of this study was to determine whether, during early postnatal development, activity propagated by long-range horizontal cortical connections can induce long-term changes in the location of a neuron’s classical receptive field. We investigated this issue by looking for receptive field location changes among neurons in cat primary visual cortex that had their intrinsic horizontal input chronically altered by the presence of a neighboring zone of partial feedforward input loss (created by a monocular retinal lesion made at 8 weeks postnatal). Despite receiving normal feedforward input, these neurons outside the deafferented zone underwent extensive changes in the location of their classical receptive fields. Neurons inside the deafferented zone also shifted the locations of their receptive fields, and we have previously demonstrated [4] that these shifts are consistent with changes in horizontal connectivity (catalyzed by increases in neuronal gain) that are spike timing-dependent and inconsistent with changes that are spike correlation-dependent. Here we applied the same model to reorganization outside the deafferented zone, and a comparison of the simulated and \textit{in vivo} receptive field shifts reveals that the same plasticity principles underlie the connectivity changes in this region also. Our results indicate that intrinsic horizontal cortical connections, via spike timing-dependent plasticity, do indeed have the capacity to exert a powerful influence on receptive field location, but this capacity is kept under strict control via a close coupling of the excitation and inhibition elicited by horizontal input. Our results, therefore, support the fundamental assumption of topographic map development models that intrinsic long-range cortical connectivity has the capacity to shape long-term changes in neuronal receptive field location.

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**References**