Subplate Neurons and Functional Maturation of Thalamocortical Synapses

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transient population of neurons. Subplate neurons are the first to mature in the developing cortex but then later die during further development. The axons of the subplate neurons reach into the developing cortex at a very early stage. Later, on the way to the cortex, thalamic axons pass through the subplate and wait there before they grow into the developing cortex. In part because of the brief life span of subplate neurons, very little is known about their function.

However, subplate neurons are in a key, intermediate position to control the flow of information into the developing cortex when first spontaneous (prenatal) and then visual (postnatal) activity are present in visual cortex. The fact that ODCs emerge even before the onset of patterned visual experience (1, 2), poses the question how subplate neurons influence the functional development of cortex. The subplate forms a transient circuit that is required for the development of axonal projections between thalamus and cerebral cortex. When subplate neurons are ablated after the arrival of thalamic inputs to layer 4 (P7-P10), ODCs do not form despite the robust presence of thalamic axons (3). We found that in addition to defects in the anatomical organization of visual cortex, late subplate ablation (using kainic acid or ME20.4-SAP) leads to profound functional deficits (4). Following the ablation, functional orientation maps are disorganized and visual responses are weak (4). Extracellular recordings *in vivo* showed that the orientation tuning of single neurons in visual cortex was weak and that these neurons were only weakly responsive to visual stimuli. *In vitro* slice recordings and *in vivo* current-source density measurements show that subplate ablation results in reduced efficacy of thalamocortical synaptic transmission consistent with the lower expression of GluR1 mRNA expression in layer 4 of the ablated area (4).

We conclude that subplate neurons and their connections are needed not only for the anatomical segregation of thalamic inputs into ODCs, but also for key steps in functional synaptic maturation and remodeling involved in creating the highly tuned responses of adult cortical neurons in all layers.

These observations are noteworthy because the thalamic axons from the LGN are all still present within cortical layer 4, however, they do not strengthen or refine themselves into adult patterns of connections (3, 4). In contrast, transmission from layer 4 to layer 2/3 is unaffected by subplate ablation (4) indicating that, apparently, cortex can continue to mature and develop even when not functionally activated by thalamic inputs.

References

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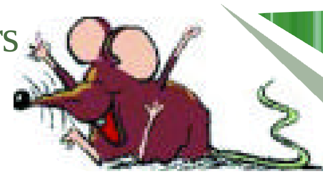

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