Relationships between the spatiotemporal structure of spike trains and cortical synchronization

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There remains considerable uncertainty about the underlying causes and functional significance of cortical oscillation and synchronization. We examined the temporal structure and synchronization of spikes in cell assemblies (groups of 4-6 cells with similar orientation preference). Recordings were made with a 5x5 microelectrode array in supragranular layers of Area 17 of cats paralyzed and anesthetized with propofol and N₂O. Auto-correlograms (rate-normalized) of 24 single-unit recordings reveal burst (100%) and oscillatory (63%) firing. The average bursting interval was 2.9 ms and the average frequency of oscillation was 49.8 Hz. Results from renewal density analysis, used to explore the source of oscillation, suggest that it arises mainly from extrinsic influences such as feedback. However, a bursting refractory period, presumably intrinsic, could also encourage oscillatory firing. When we investigated the source of synchronization for 60 cell pairs we only found moderate correlation of synchrony with bursts and oscillation. We did, nonetheless, discover a possible functional role for oscillation. In all cases of cross-correlograms that exhibited oscillation, the strength of the synchrony was maintained throughout the stimulation period. When no oscillation was apparent, 75% of the cell pairs had some decay in synchronization. We propose that structured input, which results in tight organization of latency, is a more likely candidate than oscillation for the source of synchronization. The latency differences between cell pairs ($R^2 = 0.50$), as well as the SD of the differences ($R^2 = 0.53$) were logarithmically correlated with the synchronization. The reliable synchrony at response onset could be driven by the spatial and temporal correlations of the stimulus preserved through the earlier stages of the visual system. Oscillation helps to maintain the synchrony to enhance reliable transmission of the information for higher cognitive processing.