
Temporal Patterns in Sleep Mechanisms of Learning
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In the bird song system, individual neurons in the zebra finch forebrain nucleus RA exhibit neuronal replay, similar patterns of bursting activity during singing and later during undisturbed sleep and in response to song playback. This supports a sleep-learning hypothesis, which has also enjoyed recent direct behavioral observations of effects of sleep on juvenile song learning. Physiological analysis has been hampered by the lack of procedures to analyze temporal patterns of neuronal activity during sleep in the absence of a time-reference. Under this CRCNS grant, we have developed a statistical pattern filtering approach, observing a form of sleep reply in the nucleus HVC which is afferent to nucleus RA. After iterative cycles of development the technique is robust, able to detect long spike trains that exhibit significant randomness in the timing of bursts. We have also developed bootstrapping tests on the statistical significance of detected patterns and statistical methods to analyze the fine temporal structure of bursting activity in RA. Using these techniques, we have demonstrated small changes in the a small percentage of burst patterns of RA neurons in adult birds comparing activity during singing before and after periods of sleep. Furthermore, modified bursts are expressed in the prior sleep period. Thus, the RA network participates in a "pre-play" function of sleep distinct from the reply function. One interpretation of these data is that the entire network, not just a few bursts of some neurons, explore a state space during sleep, with only a subset of bursts/neurons relaxing into a new state after sleep. Currently we are developing multiple single unit recording techniques, multiunit analysis procedures, and EEG analyses to explore this hypothesis in juvenile and adult birds.

PI Website

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Publications

Data papers

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Reviews

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