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Synaptic learning rate is reduced during fear learning in mouse auditory cortex

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Learning is a fundamental process in neuroscience, yet the intricate relationship between behavioural learning and the underlying mechanisms at the neuronal circuit level remains elusive. We aim to address this knowledge gap by investigating how fear conditioning influences neuronal activity and the associated neural network in the mouse auditory cortex. In this study, we examined signal and noise correlations in pairwise neuronal activity data collected during chron16
ic imaging experiments in the mouse auditory cortex. Under basal conditions, where explicit learning is absent, we observed that signal correlations, reflecting the similarity of neuronal responses to sensory stimuli, consistently preceded noise correlations, which serve as a measure of effective connectivity. In other words, tuning similarity predicted effective connectivity. However, following auditory cued fear conditioning, this relationship was altered. Specifically, the predictive power of signal correlations on noise correlations decreased. Furthermore, employing a minimal network model, we found that this decrease in predictive power could be attributed to a reduction in synaptic learning rates following fear conditioning. This finding suggests that fear conditioning may act to decelerate the ongoing process of statistical learning, where new information continually overwrites old information. Our results propose that in the absence of behavioural learning, inputs to sensory cortex constantly overwrite the network structure. Fear learning appears to slow down this process, potentially facilitating the transfer of information to long-term memory storage.

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