Hebbian-like functional plasticity in the auditory cortex of the behaving monkey

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Created 1/26/2011
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Abstract:
In this study, the necessary conditions, including those related to behavior, for lasting modifications to occur in correlated activity ('functional plasticity') were examined in the behaving monkey. Previously, in-vitro studies of neuronal plasticity yielded important information about possible mechanisms of synaptic plasticity, but could not be used to test their functionality in the intact, behaving brain. In-vivo studies usually focused on analysis of the responsiveness of single cells, but did not examine interactions between pairs of neurons. In this study, we combined the two approaches. This was achieved by recording extracellularly and simultaneously the spike activity of several single cells in the auditory cortex of the behaving monkey. The efficacy of neuronal interactions was estimated by measuring the correlation between firing times of pairs of single neurons. Using acoustic stimuli, a version of cellular conditioning was applied when the monkey performed an auditory discrimination task and when it did not. We found that: (i) functional plasticity is a function of the change in correlation, and not of the correlation or covariance per se, and (ii) functional plasticity depends critically on behavior. During behavior, an increase in the correlation caused a short-lasting strengthening of the neuronal coupling efficacy, and a decrease caused a short-lasting weakening. These findings indicate that neuronal plasticity in the auditory cortex obeys a version of Hebb's associative rule under strong behavioral control, as predicted by Thorndike's {"Law} of Effect".

Journal:
Neuropharmacology

Volume:
37

Pagination:
633?655

Date Published:
may

Notes:
{PMID:} 9705003
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