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Postsynaptic GABA(B) receptors contribute to the termination of Giant Depolarizing Potentials in CA3 neonatal rat hippocampus

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Abstract

© 2017 Khalilov, Minlebaev, Mukhtarov, Juzekaeva and Khazipov. During development, hippocampal CA3 network generates recurrent population bursts, so-called Giant Depolarizing Potentials (GDPs). GDPs are characterized by synchronous depolarization and firing of CA3 pyramidal cells followed by afterhyperpolarization (GDP-AHP). Here, we explored the properties of GDP-AHP in CA3 pyramidal cells using gramicidin perforated patch clamp recordings from neonatal rat hippocampal slices. We found that GDP-AHP occurs independently of whether CA3 pyramidal cells fire action potentials (APs) or remain silent during GDPs. However, the amplitude of GDP-AHP increased with the number of APs the cells fired during GDPs. The reversal potential of the GDP-AHP was close to the potassium equilibrium potential. During voltage-clamp recordings, current-voltage relationships of the postsynaptic currents activated during GDP-AHP were characterized by reversal near the potassium equilibrium potential and inward rectification, similar to the responses evoked by the GABA(B) receptor agonists. Finally, the GABA(B) receptor antagonist CGP55845 strongly reduced GDP-AHP and prolonged GDPs, eventually transforming them to the interictal and ictal-like discharges. Together, our findings suggest that the GDP-AHP involves two mechanisms: (i) postsynaptic GABA(B) receptor activated potassium currents, which are activated independently on whether the cell fires or not during GDPs; and (ii) activity-dependent, likely calcium activated potassium currents, whose contribution to the GDP-AHP is dependent on the amount of firing during GDPs. We propose that these two complementary inhibitory postsynaptic mechanisms cooperate in the termination of GDP.

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Keywords

Development, GABA, Giant depolarizing potentials, Hippocampus, Neonatal, Patch-clamp techniques

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