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研究论文

星形胶质细胞引起神经元超激发的作用机制分析

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摘要：

实验发现，星形胶质细胞表面膜上有多种神经递质受体，能积极参与脑内的信号传导，并与多种神经性疾病相关。在锥体神经元和星形胶质细胞的耦合网络中，星形胶质细胞能接受外部刺激。本文研究了在神经元和胶质细胞耦合系统中，将谷氨酸刺激加载在星形胶质细胞上的情况，发现神经元出现超激发现象，而神经元超激发是癫痫疾病的一个重要特征之一；并分析了耦合强度对该系统的影响，发现耦合强度是引起神经元超激发的关键因素。这些结果对人们认识癫痫发生的生理机制具有一定的启发作用。

关键词： 星形胶质细胞 神经元超激发 三向突触 癫痫

An Analysis on The Mechanism of Astrocytes Cause Neuronal Hyper-Excitability

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Abstract:

It is found in experiments that glial cells have a variety of neuro-transmitter receptors on their membrane. Gilial cells can integrate synaptic information and are related to multi- neuron diseases. Based on the existing theoretical work, we investigate the coupling mechanism of astrocytes and neurons by theoretical and numerical method. By stimulating the astrocytes, we got the hyper-excitable state of the neuron, and hyper-excitability is an important feature of epilepsy. Then we analyze the effects of coupling strength on the system, and find that the coupling strength is the key factor leading the neuronal hyper-excitable. These results may give some suggestions when people try to find out the physiological mechanism of epilepsy.

Keywords: Epilepsy Hyper-excitability Tripartite synapses Astrocyte

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参考文献：

1. Haydon PG. GLIA: Listening and talking to the synapse. Nat Rev Neurosci, 2001, 2(3): 185~193
2. Fields RD, Stevens-Graham B. Neuroscience: New insights into neuron-glia communication. Science, 2002, 298(5593):556~562
3. Bonvento G, Giaume C, Lorenceau J. Neuron-glia interactions: From physiology to behavior. J Physiol, 2002, 96(3): 167~168

4. Parpura V, Haydon PG. Physiological astrocytic calcium levels stimulate glutamate release to modulate adjacent neurons. Proc Natl Acad Sci USA, 2000, 97(15): 8629~8634
5. Smith SJ. Neural signalling: Neuromodulatory astrocytes. Curr Biol, 1994, 4(9): 807~810
6. Charles AC, Merrill JE, Dirksen ER, Sandersont MJ. Intercellular signaling in glial cells: Calcium waves and oscillations in response to mechanical stimulation and glutamate. Neuron, 1991, 6(6): 983~992
7. Cornell-Bell AH, Finkbeiner SM, Cooper MS, Smith SJ. Glutamate induces calcium waves in cultured astrocytes: Long-range glial signaling. Science, 1990, 247(4941):470~473
8. Dani JW, Chernjavsky A, Smith SJ. Neuronal activity triggers calcium waves in hippocampal astrocyte networks. Neuron, 1992, 8(3): 429~440
9. Schummers J, Yu H, Sur M. Tuned responses of astrocytes and their influence on hemodynamic signals in the visual cortex. Science, 2008, 320(5883): 1638~1643
10. Wolf F, Kirchhoff F. Imaging astrocyte activity. Science, 2008, 320(5883): 1597~1599
11. Barres B. New roles for glia. J Neurosci, 1991, 11(12): 3685~3694
12. Zhang J, Wang H, Ye C, Ge W, Chen Y, Jiang Z, Wu C. ATP released by astrocytes mediates glutamatergic activity-dependent heterosynaptic suppression. Neuron, 2003, 40(5): 971~982
13. Shelton MK, McCarthy KD. Hippocampal astrocytes exhibit Ca2+-elevating muscarinic cholinergic and histaminergic receptors in situ. J Neurochem, 2001, 74(2): 555~563
14. Kang J, Jiang L, Goldman SA, Nedergaard M. Astrocyte-mediated potentiation of inhibitory synaptic transmission. Nat Neurosci, 1998, 1: 683~692
15. Agulhon C, Petravicz J, McMullen AB, Sweger EJ. What is the role of astrocyte calcium in neurophysiology? Neuron, 2008, 59(6): 932~946
16. Tian GF, Azmi H, Takano T, Xu Q, Peng W, Lin J, Oberheim N, Lou N, Wang X, Zielke HR, Kang J, Nedergaard M. An astrocytic basis of epilepsy. Nat Med, 2005, 11(9): 973~981
17. Nadkarni S, Jung P. Spontaneous oscillations of dressed neurons: A new mechanism for epilepsy? Phys Rev Lett, 2003, 91(26): 268101
18. Tang FR, Lee WL, Yeo TT. Expression of the group I metabotropic glutamate receptor in the hippocampus of patients with mesial temporal lobe epilepsy. J Neurocytol, 2002，30(5): 403~411
19. Li YX, Rinzel J. Equations for InsP3 receptor-mediated [Ca2+]i oscillations derived from a detailed kinetic model: A Hodgkin-Huxley like formalism. J Theor Biol, 1994, 166(4): 461~473
20. Bezzi P, Carmignoto G, Pasti L, Vesce S, Rossi D, Rizzini BL, Pozzan T, Volterra A. Prostaglandins stimulate calcium-dependent glutamate release in astrocytes. Nature, 1998, 391(6664): 281~285
21. Pasti L, Volterra A, Pozzan T, Carmignoto G. Intracellular calcium oscillations in astrocytes: A highly plastic, bidirectional form of communication between neurons and astrocytes in situ. J Neurosci, 1997，17(20):7817~7830
22. Stevens CF, Wang Y. Facilitation and depression at single central synapses. Neuron, 1995, 14(4): 795~802
23. Parri HR, Gould TM, Crunelli V. Spontaneous astrocytic Ca2+ oscillations in situ drive NMDAR-mediated neuronal excitation. Nat Neurosci, 2001, 4(8): 803~812
24. Zhang Q, Haydon PG. Roles for gliotransmission in the nervous system. J Neural Transm, 2005, 112 (1): 121~125
25. Ullah G, Jung P, Cornell-Bell AH. Anti-phase calcium oscillations in astrocytes via inositol (1,4,5)-trisphosphate regeneration. Cell Calcium, 2006, 39(3): 197~208

本刊中的类似文章

1．刘慧,丁北生,刘洁,万柏坤,吕杨生.局限性癫痫脑电时间序列的三种复杂度计算比较[J]. 生物物理学报, 1998,14(2): 269-274
2．郁可,郁阿丽,张永胜.小波神经网络在脑电信号数据压缩与棘波识别中的应用[J]. 生物物理学报, 1998,14(2): 275-281
3．宦飞,王志中,郑崇勋.基于时频分析检测EEG中癫痫样棘/尖波的方法[J]. 生物物理学报, 2000,16(3): 539-546
4．孟欣,徐京华,顾凡及.癫痫病人脑电信号的奇异谱[J]. 生物物理学报, 2001,17(1): 86-90
5．陈啸春,盛超,郑筱祥.一氧化氮抑制海马神经元兴奋的机制研究[J]. 生物物理学报, 2001,17(3): 469-476
6．汤晓军,田心,杨卓,张涛.一种改进的近似熵——样品熵及其在颞叶癫痫患者脑电信号分析中的应用[J]. 生物物理学报, 2004,20(5): 382-392
7．邱天爽,郑效来,鲍海平,赵庚申.一种基于支持向量机技术的癫痫脑电棘尖波识别方法[J]. 生物物理学报, 2005,21(4): 317-321
8．吴俊芳,王文挺,魏晓菲,韩丹.电刺激诱导大鼠海马癫痫电网络神经信息分析[J]. 生物物理学报, 2006,22(4): 259-267
9．许新梅 王惠南 卢光明 刘兆健.颞叶癫痫脑“默认模式”的fMRI研究[J]. 生物物理学报, 2008,24(2): 139-144
10．裘嘉恒 李雅堂 许坤涵 杨卓 张涛.癫痫发作间期alpha波的窄带相位同步分析[J]. 生物物理学报, 2008,24 (3): 221-226

11. 钟元 王惠南 卢光明 郑罡 张志强 刘一军.基于时间聚类分析和独立成分分析的癫痫fMRI盲分析方法[J]. 生物物理学报, 2008,24(3): 245-250
12. 杨志根 王惠南 张志强 钟元 陈志立 卢光明.基于ICA的颞叶癫痫缺省模式网络的研究[J]. 生物物理学报, 2008,24(4): 291-297
13. 成文莲1,2，钱志余1，张志强2，陈志立2，钟元1，谭启富3，卢光明1,2.基于ReHo方法的颞叶癫痫功能磁共振成像研究[J]. 生物物理学报, 2008,24(6): 460-464
14. 张艳 陈春晓 卢光明 张志强 朱建国 陈志立 钟元.基于动态因果模型对颞叶癫痫活动传播的初步研究[J]. 生物物理学报, 2009,25(2): 148-154
15. 黄巍 卢光明 张志强 钟元 谭启富 王正阁 陈志立 翁晓光 钱志余.原发全面强直-阵挛型癫痫的体素形态学研究[J]. 生物物理学报, 2009,25(6): 441-446
16. 张浩, 钱志余, 卢光明, 张志强, 王正阁, 田蕾, 钟元, 袁翠平, 焦青.同步脑电-功能磁共振成像技术对儿童失神性癫痫的研究[J]. 生物物理学报, 2011,27(2): 167-174
17. 蔡冬梅, 周卫东, 李淑芳, 王纪文, 贾桂娟, 刘学伍.基于去趋势波动分析和支持向量机的癫痫脑电分类[J]. 生物物理学报, 2011,27(2): 175-182

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