DIFFERENCES IN GLUTAMATERGIC TRANSMISSION ONTO INTERNEURONS AND PYRAMIDAL CELLS IN THE RAT HIPPOCAMPUS

Ilse Riebe
Department of Physiology, Institute of Neuroscience and Physiology, University of Gothenburg, Sweden, 2010

Abstract
In the human brain there are about 100 billion excitatory glutamatergic neurons and 10 billion inhibitory GABAergic neurons. During development, these neurons are synaptically wired together into neural networks, functionally prepared to perform the full register of brain functions, and to learn from experiences. Much research has focused on the understanding of synapses onto excitatory neurons. Considerably less, however, is known about the properties of synapses onto the inhibitory neurons, information necessary to achieve a more complete picture of network function.

The aim of this thesis was to examine the effects of glutamate on inhibitory interneurons by comparing them to those on excitatory pyramidal cells in the same region of the hippocampus. Electrophysiological methods were used in the acute rat hippocampal slice preparation.

This thesis shows that glutamate synapses formed onto interneurons, in contrast to those formed onto pyramidal cells maintain a developmental phenotype into adulthood. First, interneurons in adult rats have AMPA silent synapses, which are created by activity dependent AMPA silencing. Second, the average number of synapses connecting a presynaptic excitatory cell and an interneuron remains only one in the adult rat. Furthermore, inhibitory interneurons rely more on tonically active extrasynaptic NMDA receptors for their excitability than do excitatory pyramidal cells.

The findings presented in this thesis suggest that some fundamental aspects of glutamate transmission onto interneurons do not change during development, as they do in synapses onto pyramidal cells. This differential development results in different phenotypes of glutamatergic transmission onto these two major groups of neurons. This difference is likely critical for the optimized functioning of the adult neural network.

Keywords: AMPA, development, glutamate transmission, hippocampus, interneuron, NMDA, synapse

ISBN: 978-91-628-8152-8

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Akademisk avhandling

som för avläggande av medicine doktorsavhandling vid Sahlgrenska akademin vid Göteborgs universitet kommer att offentligen försvaras i Hörsal Lyktan, Medicinaregatan 20A, Göteborg, fredagen den 24 september 2010 kl. 09.00

av
Ilse Riebe

Fakultetsopponent: Dr. Kimmo Jensen
Institute of Physiology and Biophysics, Århus, Danmark

Avhandlingen baseras på följande delarbeten:

I. Ilse Riebe, Bengt Gustafsson, and Eric Hanse. Silent synapses onto interneurons in the rat CA1 stratum radiatum. *European Journal of Neuroscience* **29**(9): 1870-1882.

II. Ilse Riebe and Eric Hanse. Development of synaptic connectivity onto interneurons in the CA1 region of the rat hippocampus. *Manuscript*

III. Ilse Riebe and Eric Hanse. Tonically active NMDA receptors – a signalling mechanism critical for interneuronal excitability in the CA1 stratum radiatum. *Manuscript*

Göteborg 2010

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